Vol. 36 JANUARY 15, 1928 No. 2

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JOURNAL OF AGRICULTURAL RESEARCH

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PUBLISHED BY AUTHORITY OF THE SECRETARY OF AGRICULTURE
WITH THE COOPERATION OF THE ASSOCIATION
OF LAND-GRANT COLLEGES AND
UNIVERSITIES

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON
1928

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Published on the first and fifteenth of each month. This volume will consist of twelve numbers and the Contents and Index.

Subscription price: Domestic, $4.00 a year (two volumes)
Single numbers, 20 cents
Foreign, $5.00 a year (two volumes)
Single numbers, 25 cents

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JOURNAL OF AGRICULTURAL RESEARCH

VOL. 36 WASHINGTON, D. C., JANUARY 15, 1928 NO. 2

THE DIRECT EFFECT OF POLLEN ON THE FRUIT OF THE DATE PALM [1]

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INTRODUCTION

The culture of the date palm is unique in many respects, as compared with that of the more familiar tree crops of the Temperate Zones. Not the least picturesque of the operations which characterize the industry is that of artificial pollination, necessary because of the dioecious nature of *Phoenix dactylifera* and the impracticability under commercial conditions of resorting to the natural method of wind pollination. The practice is as old as date culture itself. Obviously any direct influence which pollen may have upon the fruit is of immense practical importance to the date grower, for if available it is just as easy to use one pollen as another.

The variability of fruit-bearing palms grown from seed, the original source of all cultivated varieties, has been recognized from the beginning. It has been emphasized over and over again by the experiences of growers who have attempted to establish commercial gardens in this way and who have seldom found more than 1 or 2 per cent of such palms worthy of further propagation. Yet very little care has been used in the selection of palms for pollen. Although a few individual male offshoots came in with some of the earlier importations, at present no varieties have been established in this country. Seedling males have been used more or less indiscriminately and a good setting of fruit has generally been regarded as all that could be expected. Of course, obvious physiological differences among individual male palms have compelled attention. Because of wide variations in the time of blooming, size and number of inflorescences, quantity of pollen produced, etc., many are of little or no value.

That pollen might influence directly the fruit of the date palm has not been generally believed either by date growers or by botanists. Isolated statements without the confirmation of experimental data attract little attention. Popenoe [2] cites Schweinfurth [3] as having "declared that the characteristics of the male had an influence on the fruit which resulted." From the original it appears that Schweinfurth commented only on the variability in the size of the seed, but mentioned no other effect on the fruit. Popenoe [2] reports informally work done by Bruce Drummond when he was superintendent of the

[1] Received for publication Aug. 29, 1927; issued March, 1928.

[2] POPENOE, P. B. DATE GROWING IN THE OLD WORLD AND THE NEW. p. 108–109. Altadena, Calif. 1913.

[3] SCHWEINFURTH, G. UEBER DIE KULTUR DER DATTELPALME. Gartenflora 50: 513. 1901.

United States experiment date garden at Indio, Calif. Pollen of *Phoenix canariensis* is said to have influenced the quality of the fruit of the Rhars variety, producing a better date than was obtained on this same variety with pollen of *P. dactylifera*. In addition, on the authority of Drummond, it is reported by Popenoe that "a difference of as much as one-third in the size and of 20 days in the time of ripening seems to have been due to a change in the male used for pollinating." Drummond in his official reports to the Washington office (unpublished manuscripts) attributed marked effects on the time of ripening exerted on dates by pollen of certain male palms where both parents were cultivated varieties of *P. dactylifera*. However, in the absence of detailed records of experiments safeguarded against any possible source of error, these supposed effects remained more or less dubious, and other problems of more immediate concern in the establishment of the date industry demanded attention.

In order to throw some light on the question, a series of experiments was begun at the United States Experiment Date Garden, Indio, Calif., in the spring of 1925 and repeated on a more extensive scale in 1926.

POLLENS TESTED

As the basis of these experiments two *dactylifera* males were selected which seemed most likely to differ in their influence upon the fruit.

Fard No. 4 (fig. 1, A, and fig. 2, B) was grown from seed of imported fruit by Fred N. Johnson at Indio, Calif., and transplanted to the United States Experiment Date Garden in 1910. A description of this palm follows:

Height, 17 feet (measured to the tip of the bud as noted from the last fiber visible at the base of the youngest leaves); length of leaves, 10 to 12 feet; diameter of trunk, 26 inches (measured 3 feet above the ground and including fiber and closely pruned stubs of leaf petioles); has one offshoot remaining; in 1925 produced 14 spathes from February 6 to April 11, with two later ones the latter part of June. Though at present it is not grown in this country, the small to medium sized brownish black fruit of the Fard variety is well known to connoisseurs of dates, as it has long been imported in considerable quantities from eastern Arabia.

Mosque (fig. 1, B, and fig. 2, A) was grown from seed obtained by S. C. Mason near Kena, below Luxor, Egypt, in 1913 and planted at Indio, Calif., in 1914. A description of this palm follows:

Height, 19 feet; length of leaves, 16 to 20 feet; diameter of trunk, 31 inches; has one offshoot remaining; in 1925 produced 22 spathes from February 6 to March 24. This is a very vigorous male producing an abundance of pollen in spathes nearly twice as large as those of any other male at the United States Experiment Date Garden. Curiously enough, in view of the results obtained with pollen from this palm, Mason reports that the parent palm produced fruit which, though of excellent quality, was of only medium size.

In 1925 pollens from three other *dactylifera* palms (figs. 1 and 3) in addition to the two described were also tested, along with pollen from a *Phoenix canariensis* (Canariensis No. 1). The well-known Canary Island palm is very common in ornamental plantings in southern California. The pollen was obtained from a palm along a driveway in a neighboring community. In 1926, in addition to Mosque and Fard No. 4, pollens from 19 *dactylifera* males were tested along with pollens from two individuals of *P. canariensis*—Canariensis No. 2, a palm growing on the grounds of the Imperial County courthouse at El Centro, Calif., and Canariensis No. 3, a palm growing

FIG. 1.—Male palms whose pollens were tested: A, Fard No. 4; B, left, Deglet Noor R–6; center, Mosque

along the highway near Brawley, Calif. All of the male palms tested are of seedling origin.

Since there are likely to be differences between fruit produced on different palms of the same variety and even on the same palm to some extent between different bunches, especially as between early and late inflorescences, comparative pollinations are best made within a short range of time and on the same palm. With this in view, eight experiments were made in 1925. Seven of these were on three Deglet Noor palms, Nos. 2–8–1, 2–9–1, and 2–5–7, 15 to 16 years of age, growing at the United States Experiment Date Garden and in

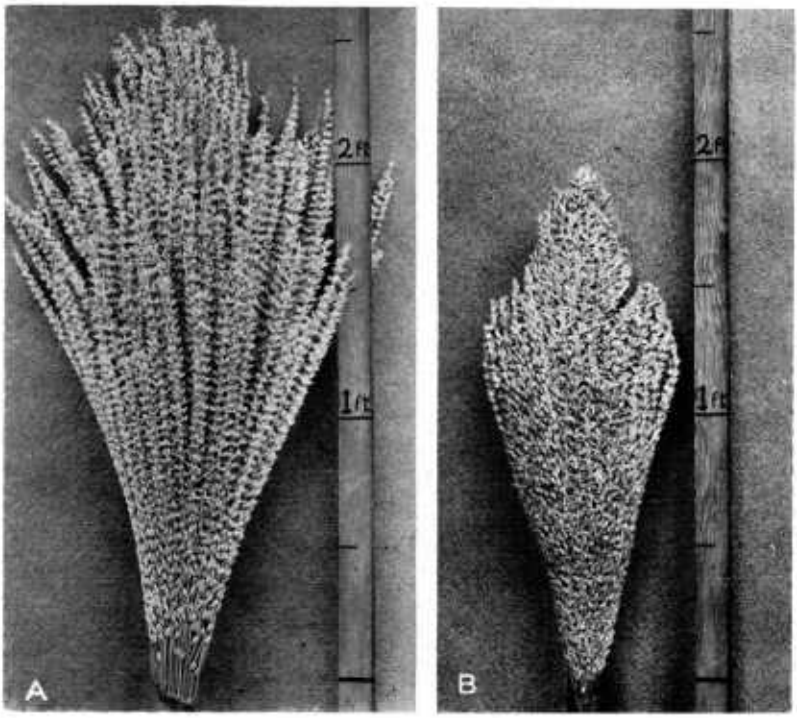

FIG. 2.—Staminate inflorescences from palms tested (the protecting sheath or spathe has been removed): A, Mosque; B, Fard No. 4

full commercial bearing. The other experiment was on Deglet Noor seedling No. 6, approximately the same age as the other three. In 1926, 19 experiments were made—10 on the 3 Deglet Noor palms mentioned above, 5 on 4 other Deglet Noor palms; 1 on Deglet Noor seedling No. 6, and 1 each on palms of the Rhars, Khadrawy, and Maktum varieties. Mosque and Fard No. 4 pollens were included in all of the experiments in 1925 and in 15 experiments in 1926; Canariensis No. 1 in 6 experiments in 1925; Canariensis No. 2 in 5 experiments and Canariensis No. 3 in 2 experiments in 1926. Along with the foregoing the other *dactylifera* pollens, comprising a total of 20 for the 2 seasons, were each tested in from 1 to 4 experiments.

In addition to those enumerated at the Indio station, nine experiments with the Mosque and Fard No. 4 pollens were made in the

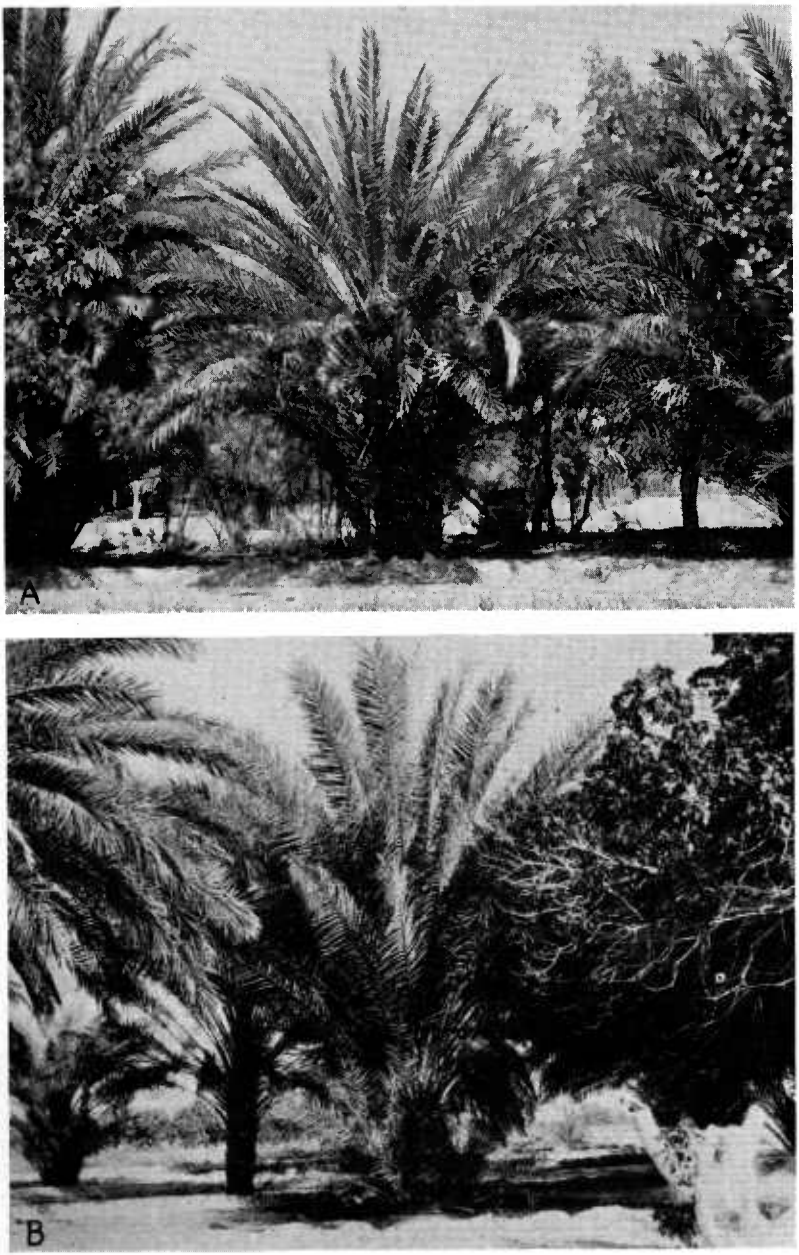

FIG. 3.—Male palms whose pollens were tested: A, Deglet Noor N-12; B, Fard FNJ-N

Salt River Valley, Ariz., in 1926—seven on two Deglet Noor palms in full bearing at the Tempe Date Garden and one on Deglet Noor and one on Iteema at the garden of the Arizona Orchards Co. The Mosque and Fard No. 4 pollens were compared directly in 30 experiments.

CARE OF POLLEN

Owing to the fine powdery nature of date pollen, special precautions are necessary in handling it. The male palms used in these tests were visited every morning and mature spathes cut as soon as they showed signs of splitting or opening. During the first season, to minimize the danger of contamination from pollen blown about in the air or transported by bees from other male palms, no spathes were allowed to mature on any male palms except those to be tested, the others being cut from the palm before opening and while still immature.

This was not done during the second season. Instead, along with improved technic in pollination and greater precautions in the field, the better method was adopted of bagging such spathes as were desired prior to opening, mostly with glassine paper bags through which the opening of the spathe could be easily observed. Each pollen was laid out to dry in shallow trays and kept locked in a separate room reached from a different entrance. To avoid storage complications most of the pollens used in only one or two experiments were gathered, prepared, and used immediately. After handling one pollen, whether cutting the spathe for storage or using it for pollination, the operator was very careful to change clothes and to wash all exposed portions of the body. Precautions were also taken with all implements used.

TECHNIC OF POLLINATION

It is difficult to bag satisfactorily an entire cluster of female flowers. When the spathe first begins to open, the basal flowers on the strands within are usually still far down in the axil of the leaf. Fortunately, the Deglet Noor produces spathes longer and narrower than most other varieties. To cover these spathes, long narrow paper bags were made of heavy brown wrapping paper, two thicknesses each, sealed separately—essentially two bags, one within the other. A close watch was kept on the growing spathes from day to day, and each flower cluster was pollinated as soon as the spathe showed the slightest tendency to crack or open. In several of the 1926 experiments the spathes were broken apart and pollination accomplished a day or two, as nearly as could be estimated, before they would have opened normally. The results of such pollinations were entirely satisfactory. In most of the other experiments at Indio in 1926 the spathes were sponged with alcohol and several days before opening covered with glassine bags, which were removed at the time of pollination.

In pollinating, a band of cotton was first tied tightly around the base of the spathe as far down in the axil of the leaf as possible. The sides of the spathe were then pulled apart and pollen applied with a tuft of cotton about the size of a walnut, three or four being placed at different elevations between the strands. After the sharp edges

were trimmed the spathe itself was left to give rigidity to the bag, which was placed over all and tied firmly to the band of cotton at the base. As a further precaution when the basal flowers were very far down in the axil of the leaf, a second band of cotton was tied around the outside and as far down at the base as it was possible to push it. The bags were examined from time to time and during the first two weeks were pushed farther down into the axil of the leaf whenever necessary to prevent exposure of the inclosed inflorescence because of the elongation of the fruit stalk.

APPLYING POLLENS FROM SEVERAL SOURCES TO THE SAME INFLORESCENCE

Under any conditions there are apt to be slight variations between the fruit of different bunches due to variations in exposure, time of blooming, etc. Hence it is very desirable for comparison to apply the different pollens on the same inflorescence. Under such conditions greater care must be used to prevent contamination, but this is partially offset by the greater efficiency of bagging, for it is possible to put cotton all around each individual strand when only a few are used and there is no danger of subsequent exposure because of the growth of the fruit stalk.

Several pollens were applied to different strands on the same inflorescence in three of the experiments on Deglet Noor in 1925 (Nos. 4, 5, and 6). In 1926 this means of comparison was used in all of the experiments except four on Deglet Noor (Nos. 1 to 4, inclusive) at the Indio station and two on Deglet Noor (Nos. 1 and 6) at the Tempe Date Garden.

In 1925 sets of three strands each were chosen and inclosed in long narrow paper bags before any pollen was applied. As additional protection, the entire inflorescence was then inclosed in a canvas hood. In pollinating, one bag was removed from under the hood and taken off the strands; pollen was applied on all the flowers with a tuft of cotton, using a superabundance of pollen; then the strands were rebagged and left outside the canvas hood until the next pollination, or about two hours, some such interval being considered desirable to permit the wind to remove pollen which might remain in suspension in the air about the inflorescence.

A NEW METHOD FOR APPLYING ANEMOPHILOUS POLLENS

In 1926 a method was worked out for applying several pollens to different strands on the same inflorescence which greatly facilitates field work and insures a minimum of contamination. This consists in sealing the pollens in small paper packets, about 2½ by 5 inches, and gluing these small packets within the larger bags, about 3 by 24 inches, at the upper or sealed end. After the large bag has been placed over the strands to be pollinated and the lower or open end plugged with cotton and tied, the pollen is released by pulling a copper wire attached to a small tuft of cotton inside the sealed packet that contains the pollen. This breaks the pollen packet and releases pollen so it falls on the female flowers. This is not done until all of the bags are in position (fig. 4), and is accomplished by holding the upper end of the bag with one hand and pulling the lower end of the copper wire with the other. The small packets used were made of heavy glassine paper, two thicknesses each sealed separately, and

before being placed within the pollination bags they were washed in a strong solution of bichloride of mercury. The 3 by 24 inch bags were similarly made of two thicknesses of glassine paper, each sealed separately, and it was possible to observe the action of the wire plunger in effecting pollination.

This method eliminates the necessity for direct contact with pollen in the field, and the pistillate flowers are exposed only during the few moments while the bags are being placed in position. As was

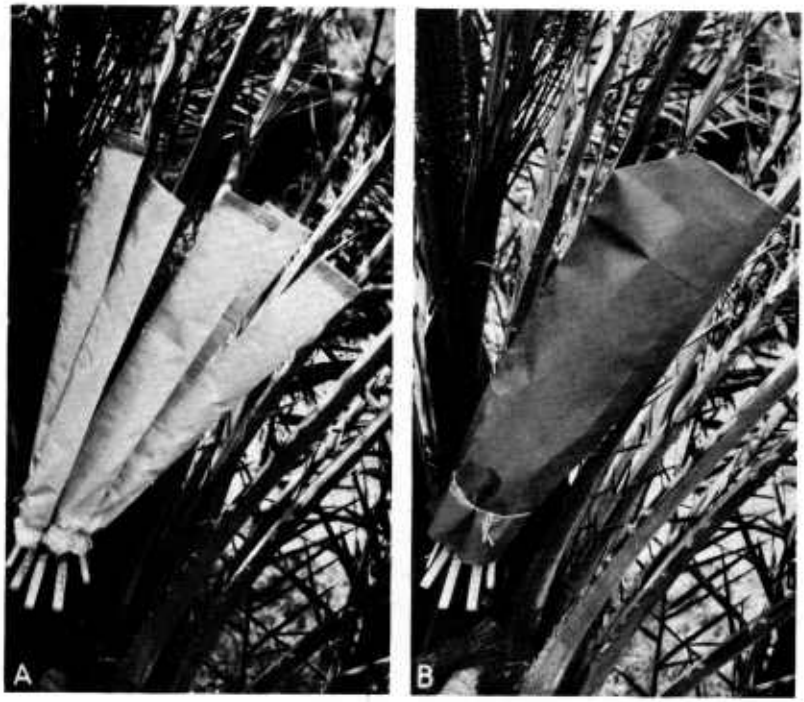

FIG. 4.—Type of bags used in experiments with different pollens on the same inflorescence. Each bag in A incloses a set of strands. Emerging from the bags at the base are the copper wires used to release pollen sealed in small packets at the upper end within. B shows a larger bag placed over the others for additional protection

done in these experiments, it is advisable to protect all the bags on a single inflorescence with a larger bag or hood.

EFFICIENCY OF TECHNIC

In the 1925 experiments two entire bunches were bagged without the application of any pollen. In one of these unpollinated treatments 1,755 dates developed, of which 14 (0.79 per cent) contained seed; in the other 1,266 dates developed, of which 32 (2.5 per cent) contained seed. In three similar unpollinated treatments in 1926 seeds were contained as follows: 5 out of 2,106, 3 out of 1,104 and 7 out of 588—almost negligible except the last, 1.2 per cent. This may be regarded as an approximate indication of the efficiency of this type of bagging; but it should also be stated that since both of the clusters in 1925 and the last mentioned in 1926 were not bagged

until the morning when the first indication of opening was observed, it is probable that in these three cases some of the pollen reached the flower clusters before they were bagged. This was indicated by the fact that the dates which contained seed were on that portion of the cluster which was first exposed by the opening of the spathe.

Each pistillate date flower contains three ovules. When pollinated, only one of these normally develops to maturity; the other two usually dry up and slough off. In most varieties if the unpollinated dates develop at all there is a slight but more or less equal development of all three ovules, sometimes crowding on the strand, resulting in a thick mass of miniature seedless dates. In the Deglet Noor variety the development of a large percentage of single dates on unpollinated inflorescences seems to be characteristic, although unpollinated inflorescences are not likely to develop as many dates as pollinated ones.

In each of the experiments at the Indio station in which several pollens were applied to the same inflorescence, an unpollinated treatment was included, to determine the degree of exposure to foreign pollen. In these, with a few exceptions, not many unpollinated dates developed, so that the proportion of dates with seed to those without would not be even an approximate indication of the efficiency of technic. However, out of 18 experiments at Indio only 4 of the unpollinated treatments developed any seed at all, and except for 4 in No. 13 in 1926 there was only 1 in each of these—No. 4 in 1925 and Nos. 14 and 17 in 1926. It does not appear, therefore, that sufficient foreign pollen could have reached the stigmas to have seriously impaired the reliability of the series of experiments. In the few cases mentioned it is very likely that air currents carried the pollen to the pistillate flowers during the few moments of exposure before they were bagged.

SEEDS PRODUCED BY CANARIENSIS POLLEN

Another indication of the care taken in handling the various pollens was afforded by a study of the seed resulting from the *canariensis* pollinations. These were found not only to average smaller than the seed resulting from any other pollination but also to have a characteristic tapering toward the basal end. (Fig. 5, A.) In the *canariensis* pollinations in 1925, of the three experiments containing this pollen on the same inflorescence with others, two had no off-type seed, but the third had 3 out of 30 which appeared to be the result of foreign pollen, or a possible contamination of 10 per cent. In the other three *canariensis* pollinations, each representing an entire bunch, the first had 3 dates which probably received foreign pollen; the second, 3; and the third only 1 out of 100 dates examined in each experiment. In 1926 out of 30 dates taken at random from each of the 7 experiments in which *canariensis* pollen was used, none of them were found to contain off-type seed. In one of these experiments (No. 3) 2 out of the 30 seeds examined were rough coated, but while slightly larger than the others there was not sufficient difference in size or shape to make it certain that other pollen had been introduced.

On the other hand, as another possible indication of the care taken in handling the various pollens, it should be noted that in all of the other experiments no seed resulted from the *dactylifera* pollinations which resembled those produced by the *canariensis*.

However, in judging the relative purity of pollination by the appearance of the seed, while the foregoing conclusions seem probable, the assumption is not justified that because a characteristic size or shape occasionally fails to appear some other pollen is necessarily responsible. Possibly the only absolute test of the purity of date pollinations would be the palms which the seed in question produced. To

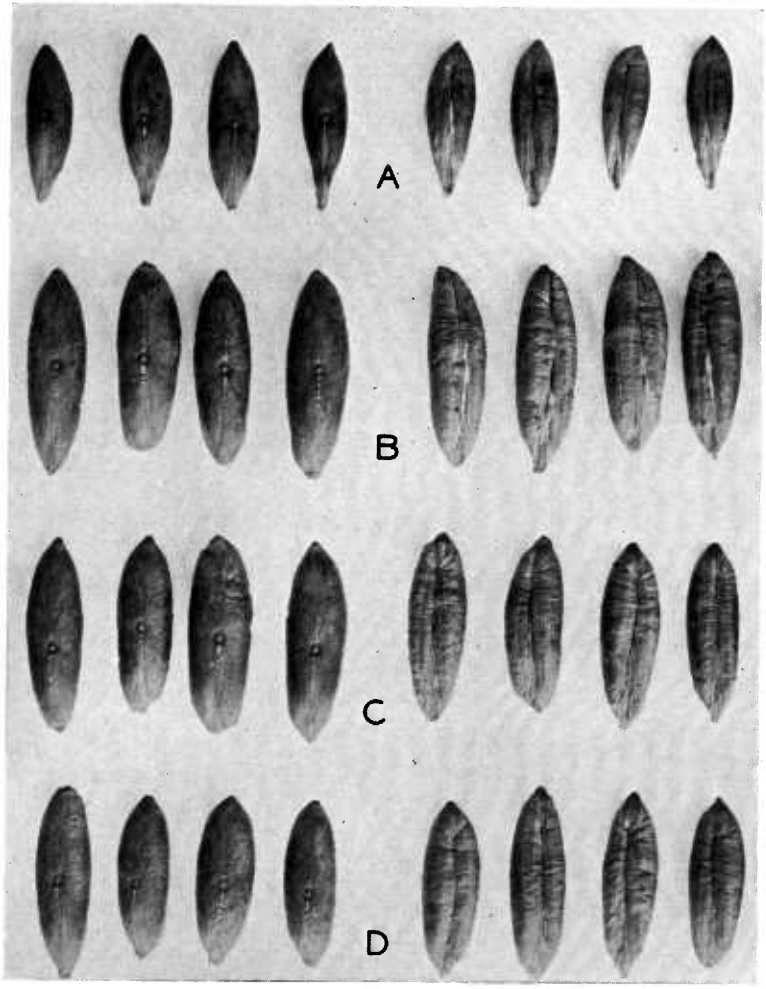

FIG. 5.—Typical Deglet Noor seeds produced on the same cluster by different pollens in experiment 5 in 1925. The male palms represented are: A, Canariensis No. 1; B, Mosque; C, Government No. 1; and D, Fard No. 4

get such proof would require many years and would even then be subject to question because of the absence of genetically pure strains of pollen.

OFF-TYPE SEEDS

Seeds entirely normal in appearance but showing marked variation from the average type in any one pollination naturally suggest

foreign pollen. On the other hand, seeds of abnormal appearance sometimes occur under such conditions as to make it very likely that some physiological disturbance in the development of the embryo and endosperm is responsible rather than another pollen. In a few of the Fard pollinations, both in 1925 and in 1926, there occurred occasionally an extra large seed, generally very irregular in shape, with a long, tapering apex more or less curved to one side; light colored; ventral surface rather flat and a ventral furrow which instead of a normal closure appeared split throughout its entire length. The fruits containing such seeds were also larger than the average and remained immature much longer, rarely ripening normally. This accounts for the delayed ripening of 1 date from Fard No. 4 pollen in experiment 4, 1 in experiment 5, 1 in experiment 9, and 2 in experiment 8. Only in two or three instances did any tendency toward this particular abnormality show in any of the other pollinations, though its occasional occurrence has been noted in various commerical gardens throughout the Coachella Valley.

Here also should be mentioned another phenomenon—the occasional appearance of one or more longitudinal ridges or "wings" on the seed. These ridges if pronounced usually produce a longitudinal depression in the flesh immediately above, which is more or less prominent until the dates begin to soften. Such seed seem to occur more commonly with pollen from some palms than with that from others, but apparently may be found now and then with any pollen. Out of the *canariensis* pollinations there were one seed in 1925 and two in 1926 which developed a longitudinal ridge but which otherwise were unmistakably typical seeds produced by *canariensis* pollen.

DEVELOPMENT AND RIPENING OF FRUIT

A good setting of fruit was obtained in all of the pollinations except the *canariensis*, which was below normal. In most of the experiments the Mosque pollen gave a little better setting than the Fard No. 4, but the difference would seldom have attracted attention in a commercial garden.

As early as the first week in June, 1925, it was evident that the dates from the *canariensis* pollinations were smaller than those from the others, and even before this the smaller size of the unpollinated dates could be observed.

By the middle of July the bulk of the Deglet Noor dates in the Coachella Valley, where these tests were initiated, have usually reached about their maximum size and begin to change in color from green to a bright coral red, commonly ranging around carnelian red (R. XIV),[4] which is characteristic of the preripe stage in this variety. During the period of color change every shade from pure green to bright red may be found at the same time on the same cluster and often on the same fruit. However, differences in the rate at which the fruit from the various pollinations took on the red color were very apparent. In fact, the earlier coloring of the fruit from pollinations with Fard No. 4 was one of the striking features of these tests. Although distinguishable in all of the experiments, it was especially obvious where the pollinations were side by side on the same bunch.

[4] All color references are from RIDGWAY, R. COLOR STANDARDS AND COLOR NOMENCLATURE. 43 p., illus. Washington, D. C., 1912. Published by the author. The color cited, "carnelian red," is quoted from Ridgway's plate 14, being indicated by R. XIV.

These differences in coloring were found to be followed by subsequent differences in ripening, so in the 1926 experiments at the Indio station detailed notes were made at a time approximately in the middle portion of the period of color change. These observations are given in Table 3. Differences in the rate of ripening of the fruit are shown in Tables 1, 2, 4, and 5.

TABLE 1.—*Ripening of the fruit of Deglet Noor palms in experiments 1, 2, 3, and 7 during the year 1925, at Indio, Calif., including the percentage ripe by September 30 and that damaged by rain October 4 and 5*

Experiment	On Deglet Noor palm No.	Pollen used	Date of pollination	Weekly pickings (ounces)															Total	Percentage of fruit ripe Sept. 30	Percentage of fruit damaged by rain Oct. 4 and 5
				Aug. 27	Sept. 3	Sept. 9	Sept. 17	Sept. 23	Sept. 30	Oct. [a] 7	Oct. 15	Oct. 22	Oct. 29	Nov. 5	Nov. 12	Nov. 19	Nov. 26				
No. 1	2-8-1	Mosque	Mar. 2	18	30	34	111	114	150	132	44	74	52	14	---	---	---	773	59.1	3.1
		Fard No. 4	Feb. 23	69	55	51	124	113	40	12	---	---	---	---	---	---	---	464	97.4	.8
		Canariensis No. 1	Feb. 25	24	41	25	66	32	39	60	6	6	2	---	---	---	---	303	74.9	9.5
		Deglet Noor R-6	Feb. 27	77	53	67	107	84	117	98	36	51	4	---	---	---	---	694	72.7	4.3
No. 2	2-9-1	Mosque	Feb. 25	38	66	132	90	38	33	57	---	---	---	---	---	---	---	454	87.4	4.6
		Fard No. 4	Feb. 26	55	46	48	152	109	78	42	---	---	---	---	---	---	---	530	92.0	3.4
		Canariensis No. 1	Feb. 24	24	35	38	88	56	66	92	49	13	14	4	---	---	---	479	64.0	14.4
		Deglet Noor R-6	Feb. 26	35	36	49	117	108	135	172	19	---	---	---	---	---	---	671	71.5	9.7
No. 3	2-5-7	Mosque	Mar. 23	---	---	---	30	38	42	34	17	20	20	6	---	---	---	207	53.1	.9
		Fard No. 4	Mar. 19	---	---	---	80	52	92	67	15	14	3	---	---	---	---	323	69.3	1.2
		Government No. 1	Mar. 12	---	---	---	58	60	84	109	36	55	26	5	---	---	---	433	46.6	3.2
		Huey	Mar. 30	---	---	---	9	19	32	41	12	20	16	7	---	---	---	156	38.4	4.5
		Canariensis No. 1	Apr. 10	---	---	---	---	2	8	19	5	8	2	4	8	1	1	58	17.2	5.0
No. 4	2-9-1	Mosque	Mar. 21	---	---	28	93	73	119	199	51	29	33	20	---	---	---	645	48.5	21.5
		Fard No. 4	Mar. 22	---	---	41	113	62	84	62	---	---	---	---	---	---	---	362	82.8	4.9
		Huey	Mar. 26	---	---	16	28	26	58	116	4	---	---	---	---	---	---	248	51.6	29.4

[a] Fruit damaged by the rain on October 4 and 5 is included in the picking of October 7.

TABLE 2.—*Relative maturity of dates in experiments 4, 5, and 6 in 1925 at Indio, Calif.*

[The several pollens were applied to different strands on the same inflorescence in each experiment]

Experiment	On Deglect Noor palm No.	Pollen used	Date of pollination	Total number of fruits	August 18			August 27			September 16		
					Number of fruits		Fruits ripe and partly ripe (per cent)	Number of fruits		Fruits ripe and partly ripe (per cent)	Number of fruits		Fruits ripe and partly ripe (per cent)
					Ripe	Partly ripe		Ripe	Partly ripe		Ripe	Partly ripe	
No. 4	2-8-1	Mosque	Mar. 10	104	0	7	6.7	9	8	16.3	----	----	------
		Fard No. 4		57	18	5	40.3	37	10	82.5	----	----	------
		Government No. 1		124	0	5	4.0	12	5	13.7	----	----	------
		Canariensis No. 1		77	2	0	2.6	5	2	9.1	----	----	------
No. 5	2-9-1	Mosque	Mar. 14	127	0	0	0	3	0	2.4	----	----	------
		Fard No. 4		79	4	0	5.1	11	2	16.5	----	----	------
		Government No. 1		122	0	0	0	4	3	5.7	----	----	------
		Canariensis No. 1		49	0	0	0	0	0	0	----	----	------
No. 6	2-5-7	Mosque	Mar. 10	69	0	0	0	----	----	------	43	0	62.3
		Fard No. 4		84	8	10	21.4	----	----	------	84	0	100
		Government No. 1		124	0	0	0	----	----	------	80	7	70.2
		Canariensis No. 1		63	0	0	0	----	----	------	30	0	47.6

TABLE 3.—*Differences in coloring of dates in experimental pollinations during the period of transition from green to characteristic preripe color in 1926 at Indio, Calif.*

[Certain applications of pollen are marked with an asterisk (*) indicating that the protective bags were partially unsealed by rain on April 5]

Experiment No., variety used, and date of observation	Date of pollination	Pollen used	Total number of fruits	Fruits showing reddish tints		Remarks (relating to color)
				Number	Per cent	
No. 1, on Deglet Noor 2-8-1, July 20.	Feb. 11	Mosque	123	66	54	Well advanced.
	Feb. 14	Canariensis No. 2	89	26	29	Faint.
	Feb. 16	Deglet Noor, N-12	100	71	71	Comparable to Fard
	Feb. 18	Fard No. 4	107	71	66	Well advanced.
	Feb. 24	(No pollen)				
	Mar. 2	Fard, FNJ-S	89	34	38	Faint.
	Mar. 6	Fard, FNJ-N	80	37	46	Do.
	Mar. 12	*Menakher No. 1	112	5	4	Do.
	Mar. 13	*Maktum No. 5	99	11	11	Do.
	Mar. 24	*Deglet Noor, R-6	104	1	1	Very faint.
No. 2a, on Deglet Noor 2-9-1, July 19.	Feb. 16	Mosque	78	22	28	Faint.
	do	Canariensis No. 3	27	8	30	Do.
	do	(No pollen)				
	Feb. 17	Fard No. 4	72	44	61	Intermediate.
	Feb. 20	Maktum No. 5	75	25	33	Faint.
No. 2b, on Deglet Noor 2-9-1, July 27.	Mar. 2	Fard, FNJ-S	96	94	98	Well advanced.
	Mar. 8	Fard, FNJ-N	80	78	98	Do.
	Mar. 10	Deglet Noor, N-10	82	32	39	Intermediate.
	Mar. 15	*Mosque	122	8	7	Very faint.
	do	*Fard No. 4	96	51	53	Faint.
	Mar. 20	*Deglet Noor, N-18	95	20	21	Very faint.
No. 3, on Deglet Noor 2-5-7, July 27.	Mar. 1	Canariensis No. 3	73	44	60	Faint.
	Mar. 9	*Mosque	98	19	19	Do.
	Mar. 10	*Fard No. 4	71	43	61	Do.
	Mar. 15	*Government No. 1	70	19	27	Very faint.
	Mar. 22	*(No pollen)				
No. 4, on Deglet Noor 2-8-1, July 16.	Feb. 11	Mosque	128	44	34	Intermediate.
		Fard No. 4	63	7	75	Well advanced
		Canariensis No. 2	94	16	17	Very faint.
		Deglet Noor, N-12	98	42	42	Intermediate.
No. 5, on Deglet Noor 2-8-1, July 27.	Mar. 20	Mosque	147	25	17	Faint.
		Fard No. 4	89	83	93	Faint, few intermediate.
		Saidy, No. 13	117	49	42	Faint.
		Deglet Noor, N-18	105	27	26	Do.
No. 6, on Deglet Noor 2-8-1, July 27.	Mar. 23	Mosque	98	20	20	Faint.
		Fard No. 4	84	55	65	Faint, few intermediate.
		Deglet Noor, R-1	109	45	41	Faint.
		Deglet Noor, R-6	127	9	7	Very faint.
No. 7, on Deglet Noor 2-9-1, July 27.	Feb. 26	Fard No. 4	94	91	97	Well advanced.
		Fard, FNJ-S	57	55	96	Do.
		Canariensis No. 2	27	18	67	Faint.
		Maktum No. 5	80	63	79	Intermediate.
		Maktum No. 6	85	81	95	A little behind Maktum No. 7.
		Maktum No. 7	91	87	96	Well advanced.
No. 8, on Deglet Noor 2-9-1, July 27.	Mar. 8	Mosque	69	24	35	Less advanced than Fard.
		Fard No. 4	83	72	87	Well advanced.
		Menakher No. 1	68	35	51	Intermediate.
		Thoory No. 20	59	33	56	Do.
		Saidy No. 25	64	35	55	Do.
		Fard, FNJ-N	83	81	97	Well advanced.
		Deglet Noor, N-9	82	46	56	Intermediate.
		Ascherasi	89	54	61	Do.
No. 9, on Deglet Noor 2-5-7, July 16.	Feb. 25	Mosque	84	12	14	Faint.
		Fard No. 4	45	17	38	Intermediate.
		Fard, FNJ-S	44	19	43	Do.
		Canariensis No. 2	57	4	7	Very faint.
		Deglet Noor, N-9	81	24	30	Faint.
No. 10, on Deglet Noor 2-8-2, July 27.	Mar. 8	Ascherasi	86	82	95	Intermediate.
		Deglet Noor, N-9	88	70	80	Do.
		Thoory No. 20	56	44	79	Do.

TABLE 3.—*Differences in coloring of dates in experimental pollinations during the period of transition from green to characteristic preripe color in 1926 at Indio, Calif.*—Continued

Experiment No., variety used, and date of observation	Date of pollination	Pollen used	Total number of fruits	Fruits showing reddish tints		Remarks (relating to color)
				Number	Per cent	
No. 11, on Deglet Noor 2-9-2, July 27.	Mar. 9	Fard No. 4	45	40	89	Intermediate.
		Fard, FNJ-N	57	53	93	Do.
		Saidy No. 25	92	62	67	Do.
		Deglet Noor, N-9	76	37	49	Faint.
No. 12, on Deglet Noor 2-6-3, July 27.	Mar. 9	Maktum No. 5	99	21	21	Faint.
		Maktum No. 6	101	29	29	Do.
		Thoory No. 20	102	13	13	Very faint.
No. 13, on Deglet Noor seedling No. 6, July 19.	Mar. 10	Mosque	52	25	48	Less advanced than Fard.
		Fard No. 4	87	87	100	Well advanced.
		Canariensis No. 2	99	90	91	Less advanced than Fard.
No. 14, on Rhars, 1-8-6, July 13.	Feb. 15	Mosque	23	0	0	
		Fard No. 4	16	9	56	
		Canariensis No. 2	50	19	38	Preripe color, yellow.
No. 15, on Khadrawy, 2-1-8, July 27.	Mar. 24	Mosque	38	8	21	
		Fard No. 4	39	21	54	Preripe color, yellow.
No. 16, on Maktum, 2-7-7, July 27.	Mar. 13	Mosque [a]	57	10	18	
		Fard No. 4	93	57	61	
		Maktum No. 5	60	21	35	Preripe color, yellow.
No. 17, on Deglet Noor 2-4-4, Aug. 19.	Apr. 12	Mosque	56	45	80	Faint.
		Fard RB No. 1	69	67	97	Intermediate.
No. 18, on Deglet Noor 2-4-4, Aug. 19.	Apr. 14	Mosque	45	37	82	Faint.
		Fard A-21-2-32	50	48	96	Intermediate.

[a] Two strands only, one having been broken off.

TABLE 4.—*Progressive ripening of dates resulting from experimental pollinations in 1926 at Indio, Calif.*

Experiment No. and variety used	Date of pollination	Pollen used	Total number of fruits	Aug. 17			Aug. 18			Aug. 27			Sept. 3			Sept. 13			Sept. 14			Sept. 30		
				Number of fruits		Fruits ripe and partly ripe (per cent)	Number of fruits		Fruits ripe and partly ripe (per cent)	Number of fruits		Fruits ripe and partly ripe (per cent)	Number of fruits		Fruits ripe and partly ripe (per cent)	Number of fruits		Fruits ripe and partly ripe (per cent)	Number of fruits		Fruits ripe and partly ripe (per cent)	Number of fruits		Fruits ripe and partly ripe (per cent)
				Ripe	Partly ripe		Ripe	Partly ripe		Ripe	Partly ripe		Ripe	Partly ripe		Ripe	Partly ripe		Ripe	Partly ripe		Ripe	Partly ripe	
No. 1, Deglet Noor 2-8-1	Feb. 11	Mosque	115	24	7	27	----	----	------	70	12	71	99	3	89	109	6	100	----	----	------	----	----	------
	Feb. 14	Canariensis No. 2	85	15	3	21	----	----	------	45	5	59	59	4	74	71	4	88	----	----	------	84	1	100
	Feb. 16	Deglet Noor N-12	95	36	3	41	----	----	------	77	3	84	92	1	98	95	----	100	----	----	------	----	----	------
	Feb. 18	Fard No. 4	106	30	9	37	----	----	------	75	13	83	99	2	95	104	2	100	----	----	------	----	----	------
	Mar. 2	Fard FNJ-S	87	24	3	31	----	----	------	67	6	84	80	1	93	85	2	100	----	----	------	----	----	------
	Mar. 6	Fard FNJ-N	79	19	5	30	----	----	------	65	2	85	71	2	92	78	0	99	----	----	------	79	----	100
	Mar. 12	Menakher No. 1	109	4	2	6	----	----	------	24	12	33	39	7	42	80	13	85	----	----	------	109	----	100
	Mar. 13	Maktum No. 5	99	10	1	11	----	----	------	29	6	35	51	2	54	80	4	85	----	----	------	99	----	100
	Mar. 24	Deglet Noor R-6	96	2	0	2	----	----	------	5	7	13	13	8	22	48	8	58	----	----	------	95	0	99
No. 2a, Deglet Noor 2-9-1	Feb. 16	Mosque	76	9	5	18	----	----	------	26	11	49	51	5	74	71	3	97	----	----	------	76	----	100
	do	Canariensis No. 3	26	8	3	42	----	----	------	17	1	69	19	1	77	21	3	92	----	----	------	26	----	100
	Feb. 17	Fard No 4	70	28	11	56	----	----	------	62	0	89	68	0	97	70	----	100	----	----	------	----	----	------
	Feb. 20	Maktum No 5	75	11	8	25	----	----	------	35	12	63	60	3	84	72	2	99	----	----	------	75	----	100
No. 2b, Deglet Noor 2-9-1	Mar. 2	Fard FNJ-S	94	30	8	40	----	----	------	87	4	97	92	0	98	93	0	99	----	----	------	94	----	100
	Mar. 8	Fard FNJ-N	79	20	8	35	----	----	------	60	5	82	72	2	94	79	----	100	----	----	------	----	----	------
	Mar. 10	Deglet N-10	79	11	5	20	----	----	------	24	4	35	37	5	53	58	7	82	----	----	------	79	----	100
	Mar. 15	Mosque	120	0	2	2	----	----	------	15	6	18	26	10	30	55	19	62	----	----	------	120	----	100
	do	Fard No. 4	95	11	6	18	----	----	------	36	8	46	61	21	86	93	2	100	----	----	------	----	----	------
	Mar. 20	Deglet Noor N-18	94	3	0	3	----	----	------	11	5	17	26	7	35	49	8	61	----	----	------	87	3	96
No. 3, Deglet Noor 2-5-7	Mar. 1	Canariensis No. 3	70	3	1	6	----	----	------	8	8	23	15	6	30	37	8	64	----	----	------	62	1	90
	Mar. 9	Mosque	90	0	0	0	----	----	------	3	4	8	7	3	11	37	7	49	----	----	------	66	14	89
	Mar. 10	Fard No. 4	71	1	3	6	----	----	------	18	7	35	30	3	46	38	4	59	----	----	------	69	1	99
	Mar. 15	Government No. 1	68	0	0	0	----	----	------	5	8	19	11	5	24	26	5	46	----	----	------	65	1	97
No. 4, Deglet Noor 2-8-1	Feb. 11	Mosque	122	57	5	51	----	----	------	113	4	96	122	0	100	----	----	------	----	----	------	----	----	------
		Fard No. 4	60	50	7	95	----	----	------	59	0	98	59	0	98	60	----	100	----	----	------	----	----	------
		Canariensis No. 2	91	13	6	21	----	----	------	34	6	44	41	2	47	63	2	71	----	----	------	89	2	100
		Deglet Noor N-12	54	45	5	93	----	----	------	54	----	100	----	----	------	----	----	------	----	----	------	----	----	------

TABLE 4.—*Progressive ripening of dates resulting from experimental pollinations in 1926 at Indio, Calif.*—Continued

Experiment No. and variety used	Date of pollination	Pollen used	Total number of fruits	Aug. 17			Aug. 18			Aug. 27			Sept. 3			Sept. 13			Sept. 14			Sept. 30		
				Number of fruits		Fruits ripe and partly ripe (per cent)	Number of fruits		Fruits ripe and partly ripe (per cent)	Number of fruits		Fruits ripe and partly ripe (per cent)	Number of fruits		Fruits ripe and partly ripe (per cent)	Number of fruits		Fruits ripe and partly ripe (per cent)	Number of fruits		Fruits ripe and partly ripe (per cent)	Number of fruits		Fruits ripe and partly ripe (per cent)
				Ripe	Partly ripe		Ripe	Partly ripe		Ripe	Partly ripe		Ripe	Partly ripe		Ripe	Partly ripe		Ripe	Partly ripe		Ripe	Partly ripe	
No. 5, Deglet Noor 2-8-1	Mar. 20	Mosque	146	3	1	3				15	6	14	34	4	26	51	16	46				142	2	99
		Fard No. 4	86	12	4	19				37	6	50	56	4	70	77	2	92				85	0	99
		Saidy No. 13	116	8	3	9				28	6	29	36	3	34	58	17	65				116		100
		Deglet Noor N-18	102	4	0	4				11	2	13	23	3	25	51	7	57				93	4	95
No. 6, Deglet Noor 2-8-1	Mar. 23	Mosque	98	0	2	2				9	6	15	19	3	22	40	7	48				87	6	95
		Fard No. 4	83	8	7	18				27	12	47	40	7	57	71	6	93				83		100
		Deglet Noor R-1	107	3	3	6				19	10	27	31	7	36	53	14	63				106	1	100
		Deglet Noor R-6	122	1	0	1				2	1	2	5	0	4	20	11	25				104	9	93
No. 7, Deglet Noor 2-9-1	Feb. 26	Fard No.4	94	21	7	30				71	13	89	87	4	97	92	0	98				94		100
		Fard FNJ-S	55	15	8	42				45	6	93	53	0	96	54	0	98				55		100
		Canariensis No. 2	25	0	1	4				5	0	20	5	2	28	12	1	52				25		100
		Maktum No. 5	79	8	4	15				35	7	53	49	7	71	75	2	97				79		100
		Maktum No. 6	83	10	5	18				52	12	77	70	7	93	82	0	99				83		100
		Maktum No. 7	92	7	11	20				60	14	80	83	4	95	89	1	98				92		100
No. 8, Deglet Noor 2-9-1	Mar. 8	Mosque	67	2	2	6				17	7	36	30	2	48	44	3	70				62	2	96
		Fard No. 4	82	15	3	22				37	3	49	43	4	57	56	11	82				79	1	98
		Menakher No. 1	67	0	1	1				14	10	36	29	12	61	50	5	82				63	0	94
		Thoory No. 20	60	5	3	13				20	6	43	37	12	82	51	2	88				60		100
		Saidy No. 25	58	0	4	7				20	7	47	22	10	55	47	7	93				58		100
		Fard FNJ-N	82	10	4	17				44	13	70	72	1	89	80	1	99				81	1	100
		Deglet Noor N-9	83	3	3	7				25	7	39	35	2	45	54	6	72				83		100
		Ascherasi	90	6	8	15				31	23	60	55	14	77	83	5	98				89	1	100
No. 9, Deglet Noor 2-5-7	Feb. 25	Mosque	82	5	9	17				39	9	59	55	4	72	73	6	96				81	1	100
		Fard No 4	44	9	12	48				33	5	86	41	1	95	43	0	98				43	0	98
		Fard FNJ-S	42	9	9	43				32	4	86	39	2	97	41	0	98				41	0	98
		Canariensis No. 2	57	0	0	0				21	4	44	27	1	49	36	10	81				57		100
		Deglet Noor N-9	81	4	11	19				36	5	51	44	4	59	72	4	94				81		100

No 10, Deglet Noor 2-8-2	Mar. 8	Ascherasi	83	13	15	34				60	13	88	76	6	99	83		100						
		Deglet Noor N-9	88	12	6	20				47	14	69	62	10	82	78	4	93				88		100
		Thoory No. 20	55	14	6	36				40	5	82	51	3	98	55		100						
No. 11, Deglet Noor 2-9-2	Mar. 9	Fard No. 4	42	19	8	64				37	0	88	38	0	90	40	0	95				42		100
		Fard FNJ-N	57	18	7	44				55	1	98	56	1	100									
		Saidy No. 25	92	7	11	20				57	16	79	82	2	91	90	0	98				91	0	99
		Deglet Noor N-9	76	2	6	11				46	5	67	64	7	93	73	2	99				76		100
No. 12, Deglet Noor 2-6-3	do	Maktum No. 5	95	2	0	2				5	2	7	17	8	26	41	9	53				94	1	100
		Maktum No. 6	93	2	2	4				5	5	11	19	6	27	48	12	65				92	0	99
		Thoory No. 20	99	1	1	2				3	5	8	20	4	24	44	19	63				99		100
No. 13, Seedling 20-6	Mar. 10	Mosque	52	9	2	21				17	2	36	25	6	60	42	2	85				52		100
		Fard No. 4	76	16	6	29				38	5	57	52	5	75	69	5	97				76		100
		Canariensis No. 2	98	3	3	6				8	1	9	20	1	21	30	8	39				59	8	68
No. 14, Rhars 1-8-6 [a]																								
No. 15, Khadrawy 2-1-8	Mar. 24	Mosque	36				5	2	19															
		Fard No. 4	39				17	2	49															
No. 16, Maktum 2-7-7	Mar. 13	Mosque [b]	57	0	0	0							0	5	9	10	13	40				45	3	84
		Fard No. 4	93	2	6	9							35	26	66	72	14	92				93		100
		Maktum No. 5	60	0	2	3							18	0	30	34	5	65				58	1	98
No. 17, Deglet Noor 2-4-4	Apr. 12	Mosque	56																0	3	5	29	19	86
		Fard RB No. 1	69																2	22	35	61	6	97
No. 18, Deglet Noor 2-4-4	Apr. 14	Mosque	45																1	2	7	21	15	80
		Fard A-21-2-32	47																12	12	51	43	3	98

[a] All the dates ripened before the first notes on maturity were made.

[b] Two strands only.

TABLE 5.—*Relative maturity of dates resulting from experimental pollinations in the Salt River Valley, Ariz., in 1926*

[Experiments 1–7 were at the Tempe Date Garden, and experiments 8 and 9 were at the garden of the Arizona Orchards Company. Pollens from different sources were applied on the same bunch in each experiment except 1 and 6]

Experiment No., variety used, and date of observation	Pollen used	Date of pollination	Total number of fruits	Number of fruits		Fruits ripe and partly ripe (per cent)
				Ripe	Partly ripe	
No. 1, Deglet Noor No. 1, Sept. 20.	Mosque	Mar. 30	93	27	25	56
	Fard No. 4	do	47	31	13	94
No. 2, Deglet Noor No. 1, Sept. 20.	Mosque	do	68	22	12	50
	Fard No. 4	do	33	18	9	82
No. 3, Deglet Noor No. 1, Sept. 20.	Mosque	Mar. 31	55	17	15	58
	Fard No. 4	do	59	49	4	90
No. 4, Deglet Noor No. 1, Sept. 20.	Mosque	Mar. 30	45	13	15	62
	Fard No. 4	do	68	51	14	96
	Fard FNJ–S	do	71	43	13	79
	Fard FNJ–N	do	18	16	1	94
No. 5, Deglet Noor No. 2, Sept. 21.	Mosque [a]	do	44	17	8	57
	Fard No. 4	do	70	39	18	82
	Fard FNJ–N	do	61	34	20	89
	Fard FNJ–S [b]	do	56	36	9	80
No. 6, Deglet Noor No. 2, Sept. 21.	Mosque	do	50	11	13	48
	Fard No. 4	do	64	20	29	77
	Fard FNJ–S	Mar. 31	44	17	12	66
No. 7, Deglet Noor No. 2, Sept. 21.	Mosque	Mar. 30	57	10	8	32
	Fard No. 4	do	45	18	14	71
No. 8, Deglet Noor, Sept. 22.	Mosque	Mar. 29	51	0	0	0
	Fard No. 4	do	50	13	5	36
No. 9, Iteema, Sept. 22.	Mosque	do	19	0	2	11
	Fard No. 4	do	28	[c] 9	1	36

[a] Two strands.
[b] One strand.
[c] Six of these had already been picked, but the calyxes remaining left no doubt about it.

In experiments 1, 2, 3, and 7 in 1925, in which each of the several pollens was applied to an entire inflorescence, weekly pickings of ripe fruit were made. (Table 1.) In experiment 8 no record of the ripening was kept, but it was very apparent that the fruit from the Fard No. 4 pollination matured earlier than that from Mosque. In all of the other experiments the record is based on the total number of dates on three typical strands from each pollination—all that were pollinated where several pollens were applied to the same inflorescence—and each observation includes the actual number of dates that were ripe or had already ripened and the number that were partly ripe.

DAMAGE FROM RAIN, FUNGI, AND LOW HUMIDITY

In 1925 the normal seasonal ripening was interrupted on October 4 and 5 by a heavy rain which caused more or less damage to fruit in the preripe stage just before the final color change from red to amber. No appreciable injury was done except in experiments 1, 2, 3, and 7. The damaged fruit, which normally would have ripened some weeks later, was picked within a few days and weighed separately, but entered in the total production. The weights were found to be about 20 per cent heavier than for an equal number of ripe dates, but this was probably more than offset by the proportion of fruits which fell

to the ground before they could be picked. Since the fruit affected had not begun to ripen, the relative damage from the rain affords a partial index to the maturity of the dates from the various pollinations. Of course the position and exposure of the different bunches also had some influence in this connection, but, as is shown in the last column of Table 1, the damage to the fruit from Fard No. 4 pollen was very low in every instance.

Following in the wake of the rain a week or so later, a period of cloudy weather accompanied by high humidity fostered a fungus which caused the development of soft rot, dates in the prerip stage having been chiefly affected. No account of the loss from this source could well be taken in the total production, as much of the rotting fruit fell to the ground from day to day and no attempt was made to pick any of it. However, the ripening had progressed so far that the loss was negligible except in experiment 3, and even in this the fruit from Fard No. 4, having nearly all ripened, was practically unaffected, though the loss of that from Mosque was estimated roughly at about 20 per cent and that from Canariensis No. 1 at about 50 per cent. Because of this unrecorded loss of fruit which would have ripened later, it is evident that in a normal season the actual percentage of early ripening fruit would probably have been less for all of these pollinations except the Fard No. 4.

In the Deglet Noor variety a small percentage of premature shriveling is not uncommon as the fruit ripens. In 1926 the season was earlier than usual, and the low humidity prevailing as the dates began to ripen produced an unusual proportion of shriveling throughout the Coachella Valley. In a few of the experiments at the Indio station as much as 5 to 10 per cent of the fruit was affected, but taking the experiments as a whole, fortunately very little appeared. In recording the ripening, fruit which shriveled before the final color change was discounted and eliminated from the total, but otherwise it was counted as ripe. Since there was no consistent tendency for more of this shriveling to appear in the fruit from one pollen than in that from another, the reliability of a series of experiments would not be appreciably affected.

FACTORS OTHER THAN POLLEN AFFECTING TIME OF RIPENING

Of the factors other than pollen which possibly may affect the time of ripening of the fruit, many, such as fertilizer, irrigation, and pruning, have not yet been subjected to intensive study, but they would have no direct bearing on the evidence presented here because they would affect equally all of the fruit on an individual palm.

In considering the ripening data, the effect of the earliness or lateness of the season should be borne in mind. Dates which begin to mature in the extreme heat of late summer ripen much more rapidly than those which mature later in the cooler fall weather. Hence, if the ripening begins only a week earlier, the last of the crop may be off the palms as much as a month earlier, the tapering effect of cooler weather being cut short. This is what occurred in 1926. Consequently, an early season tends to lessen differences in the time of ripening due to pollen, whereas a late season accentuates them.

Since the normal duration of the flowering season for an individual palm of the Deglet Noor variety is about six or seven weeks, rather

longer than that of most other varieties, it is important to consider the differences in ripening which may be due to differences in the time of blooming. To determine whether such differences exist, a record was kept in 1925 of the inflorescences on four Deglet Noor palms in commercial bearing, the same pollen being used on all of the flower clusters on each palm. There was an average difference of six weeks and four days between the opening of the first and the last spathes. Weekly pickings of ripe fruit from each cluster were made, from which it appeared that there was an average difference of approximately three weeks between the initial ripening of the first and the last clusters.

A comparison of the time of ripening of the fruit with respect to the time of pollination in Tables 1, 3, and 4 affords additional data. For instance, in Table 4, while the pollination with Mosque in experiment 2a was a month earlier than that with Mosque in experiment 2b, the actual difference in the time of ripening of the fruit was only about 12 days. Approximately the same difference is apparent in the results obtained with Fard No. 4 in these two experiments. On the other hand, the fruit from the pollination with Fard No. 4 in experiment 2b ripened very nearly on a par with that from the Mosque pollination in experiment 2a, though there was a month difference in the time of pollination.

Here again other factors cause variation. From an inspection of date gardens throughout the Coachella Valley it was evident that the differences in the time of ripening between the first and the last clusters on individual palms was much less in warmer localities where all the ripening was earlier, being in some cases almost negligible from a casual inspection. On the other hand, in localities where all the ripening was later, the differences were more in contrast than they were at the Indio station, in some instances the first clusters being practically stripped of fruit before any pickings were made from the last ones.

COMPARISON OF SIZES OF FRUITS AND SEEDS

In 1925 measurements were made in experiments 1, 2, 3, 7, and 8 of the fruits and seeds of 100 ripe dates, taken at random from not less than four pickings between September 1 and October 15. In experiments 4, 5, and 6 fewer than 100 dates were available, as indicated in the tabulations, all of which were measured at the same time after all the fruit had ripened. These measurements are given in Tables 6, 7, and 8. Similar measurements for the 1926 experiments are given in Tables 8 to 11, which, except as indicated, represent 30 dates from each pollination after all of the fruit had been picked. Each 30 were selected at random except that no abnormal fruits or seeds were measured. Those not measured were mostly deformed dates or those where two developed in the same calyx; in the seed, those imperfectly developed, as indicated by a small formless endosperm or by an exaggerated development all out of proportion. No doubtful specimens were excluded.

TABLE 6.—*Length of date fruits in the 1925 experiments at Indio, Calif.*

Experiment	Number of fruits measured	Pollen used	Measurements (millimeters) and frequencies																				Mean
			30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	
No. 1	100	Mosque						1		1		7	12	22	25	18	13	1					41.68
		Fard No. 4					1		2	8	12	24	24	17	8	2	1			1			39.64
		Deglet Noor R-6								5	10	17	27	24	12	5							40.11
		Canariensis No. 1					1	4	12	25	21	26	6	3	2								37.90
No. 2	100	Mosque								1	2	14	30	19	17	11	5	1					40.90
		Fard No. 4					1	4	14	17	19	21	12	8	2		2						39.28
		Deglet Noor R-6							1		7	21	27	24	17	2		1					40.30
		Canariensis No. 1	2	1		1	9	12	31	23	12	7	1	1									37.27
No. 3	100	Mosque									5	7	15	25	26	15	6	1					41.34
		Fard No. 4			2	2	1		2	8	24	27	27	7									38.64
		Government No. 1								2	5	22	31	25	10	5							40.22
		Canariensis No. 1				2	1	3	14	10	27	28	12	2	1								38.01
		Huey						1	1	2	6	15	22	31	15	7							40.40
No. 4	30	Mosque												1	3	4	1	12	3	4		2	44.90
		Fard No. 4							1	1	3	5	3	5	4	5	1	1				1	40.93
		Government No. 1										1	1		3	5	10	7		3			43.86
		Canariensis No. 1					1	1	1	6	5	6	7	2	1								38.50
No. 5	40	Mosque								1	1	2	8	9	14	4		1					41.17
		Fard No. 4					2	1	4	2	9	9	5	4	2	2							38.70
		Government No. 1									1	6	11	5	10	6	1						40.97
		Canariensis No. 1		1	1	1	3	7	4	6	11	5	1										36.55
No. 6	45	Mosque						2	6	6	5	9	9	4	3	1							38.71
		Fard No. 4					2	1	5	8	8	9	5	5	1	1							38.31
		Government No. 1							1	1	2	7	13	6	10	1	4						40.60
		Canariensis No. 1	1		1	2		7	8	11	13	1			1								36.51
No. 7	100	Mosque									3	3	8	14	30	19	15	7		1			42.24
		Fard No. 4					1	1	2	1	5	9	22	24	21	10	4						39.71
		Huey				1						1	2	2	1	4	18	25	21	16	5	2	44.21
No. 8	100	Mosque											1		2	5	11	22	20	19	14	6	45.92
		Fard No. 4							1	1	4	11	21	27	23	11	1						40.84

TABLE 7.—*Length of seeds of date fruits in the 1925 experiments at Indio, Calif.*

Experiment	Number of seeds measured	Pollen used	Measurements (millimeters) and frequencies																				Mean
			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	35	36	39	
No. 1	100	Mosque								1	1	4	8	18	22	20	17	7	1	1				28.29
		Fard No. 4		1				1	16	27	23	22	5	3					1			1		23.92
		Deglet Noor R-6						1		3	11	24	36	18	7									25.72
		Canariensis No. 1				15	31	28	15	7	2			1	1									20.87
No. 2	100	Mosque								2	12	10	27	27	14	5	2		1					26.44
		Fard No. 4					2	5	18	28	19	15	7	2	1					1	1	1		23.84
		Deglet Noor R-6								3	12	28	31	22	2	2								25.71
		Canariensis No. 1			2	6	17	32	23	13	3	2		1			1							21.47
No. 3	100	Mosque							1	2	8	17	17	30	19	5	1							26.44
		Fard No. 4					2	1	8	26	32	19	5	4	1	1	1							24.03
		Government No. 1								4	9	28	33	16	9	1								25.79
		Canariensis No 1			1	1	8	18	21	24	19	7		1										22.47
		Huey							1	5	2	19	21	30	16	2								26.34
No. 4	30	Mosque										3	2	9	9	6	1							27.53
		Fard No. 4					1	3	3	8	9	3	1		1								1	23.90
		Government No. 1							1		2	4	4	7	9	1	2							26.80
		Canariensis No. 1			1	1	9	6	8	2	1	1		1										21.36
No. 5	40	Mosque								1	1	4	7	12	10	4	1							26.98
		Fard No. 4				1	1	4	7	8	7	6	3	3										23.45
		Government No. 1								1	3	6	13	12	4	1								26.20
		Canariensis No. 1				1	7	12	8	10	2													21.62
No. 6	45	Mosque							3	9	13	11	8	1										24.33
		Fard No. 4					5	4	10	11	8	7												22.75
		Government No. 1							1	5	10	16	8	3	2									24.93
		Canariensis No. 1	1	1	4	7	19	9	4															19.88
No. 7	100	Mosque									4	4	10	29	29	13	10	1						27.59
		Fard No. 4							8	24	22	35	6	3	2									24.24
		Huey						1		1	1	15	9	25	20	16	11	1						27.37
No. 8	100	Mosque							1	5	18	22	24	20	7	2	1							25.67
		Fard No. 4					6	22	35	27	9	1												22.14

TABLE 8.—*Breadths of date fruits and seeds in the 1925 experiments at Indio, Calif.*

Experiment	Number measured	Pollen used	Fruit measurements (millimeters) and frequencies										Seed[a] measurements (millimeters and frequencies							
			16	17	18	19	20	21	22	23	24	Mean	5	6	7	8	9	10	11	Mean
No. 1	100	Mosque		2	5	20	58	12	3			19.82			1	48	50	1		8.51
		Fard No. 4		3	11	41	36	8	1			19.38		5	64	29	1	1		7.29
		Deglet Noor R-6		10	32	41	16	1				18.66		1	42	53	4			7.60
		Canariensis No. 1	1	8	29	44	14	3	1			18.75	1	69	28	1	1			6.32
No. 2	100	Mosque			2	16	56	22	4			20.10			4	40	52	4		8.56
		Fard No. 4			6	29	52	10	3			19.75		4	53	39	4			7.43
		Deglet Noor R-6		1	9	32	47	10	1			19.59		1	40	57	2			7.60
		Canariensis No. 1		1	18	44	28	7	2			19.28	3	65	29	1	2			6.34
No. 3	100	Mosque			6	38	53	3				19.53			1	32	64	3		8.69
		Fard No. 4		8	36	46	10					18.58		1	31	61	7			7.74
		Government No. 1			17	57	25	1				19.10			4	67	29			8.25
		Canariensis No. 1		7	32	44	17					18.71	1	19	75	5				6.84
		Huey		1	11	63	23	2				19.14			6	72	22			8.16
No. 4	30	Mosque					7	7	12	3	1	21.46		1	4	12	11	2		8.30
		Fard No. 4				3	16	6	5			20.43	1	2	23	3	1			7.03
		Government No. 1					5	11	9	5		21.46		3	21	6				7.10
		Canariensis No. 1			1	3	16	6	4			20.30		3	23	3	1			7.06
No. 5	40	Mosque				8	24	7	1			20.02			2	28	9	1		8.22
		Fard No. 4			1	9	18	11	1			20.05			20	19	1			7.52
		Government No. 1				8	21	11				20.07			4	28	8			8.10
		Canariensis		1	4	17	16	2				19.53		14	26					6.65
No. 6	45	Mosque			1	10	25	9				19.93			1	8	27	8	1	9.00
		Fard No. 4			7	24	14					19.15			16	29				7.64
		Government No. 1			4	21	15	5				19.46			3	30	10	2		8.24
		Canariensis No. 1		1	14	19	11					18.88		5	34	6				7.02
No. 7	100	Mosque			2	19	59	18	1	1		20.00			6	55	37	2		8.35
		Fard No. 4		1	9	32	55	3				19.50		3	74	23				7.20
		Huey			1	1	21	48	26	6		21.12			16	67	17			8.01
No. 8	100	Mosque						21	35	28	15	1	21.40			16	72	12			7.96
		Fard No. 4			2	7	49	30	12				20.43		4	59	37				7.33

[a] Measured at point of greatest diameter across and at right angles to the seed furrow.

TABLE 9.—*Length of date fruits in the 1926 experiments at Indio, Calif.*

[Measurements of 30 fruits were made except where a smaller number is indicated in parentheses]

Experiment	Pollen used	Measurements (millimeters) and frequencies																						
		29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	Mean
No. 1	Mosque											1	5	2	12	8			2					42.0
	Fard No. 4								2	5	13	2	3	5										38.5
	Canariensis No. 2								3	5	11	6	3	2										38.2
	Deglet Noor N-12											4	4	9	8	3	1	1						41.3
	Fard FNJ-S							1		5	6	4	6	4	4									40.2
	Fard FNJ-N									2	3	7	9	6	2	1								40.8
	Menakher No. 1									1	1	6	5	8	3	4	2							41.8
	Maktum No. 5									2	6	9	6	5	2									40.4
	Deglet Noor R-6										1	6	11	4	1	4	2	1						41.8
No. 2a	Mosque											1		1	4	6	5	10	3					44.8
	Fard No. 4									1		4	6	7	7	3	2							42.0
	Canariensis No. 3							1	2	3	8	9	4	2	1									39.6
	Maktum No. 5											2	5	4	6	10	2		1					42.9
No. 2b	Fard FNJ-S								1	2	8	1	4	8	5	1								40.8
	Fard FNJ-N										1	4	7	11	6	1								41.7
	Deglet Noor N-10								1	2	2	6	4	5	5	4	1							41.4
	Mosque									1	1	9	1	10	5	3								41.5
	Fard No. 4									3	5	12	5	4	1									40.2
	Deglet Noor N-18											2	2	6	5	11	3	1						43.1
No. 3	Mosque										1	6	10	7		3	3							41.7
	Fard No. 4								4	5	9	7	2	3										39.2
	Canariensis No. 3						3		2	5	6	7	5	2										38.1
	Government No. 1											1	3	4	8	8	4	1	1					42.3

TABLE 9.—*Length of date fruits in the 1926 experiments at Indio, Calif.*—Contd.

Experiment	Pollen used	Measurements (millimeters) and frequencies																				Mean
		29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	
No. 4	Mosque												2	1	2	6	7	4	2	4	2			44.2
	Fard No. 4								1	1	6	7	7	3	4	1								39.6
	Canariensis No. 2						1	2	3	7	9	5	2	1										37.6
	Deglet Noor N–12								1	1		4	8	8	6	2								40.5
No. 5	Mosque										1	2	2	6	8	7	4							41.8
	Fard No. 4							1	4	5	9	8	2	1										38.0
	Saidy No. 13									1	1	3	6	11	6	2								40.7
	Deglet Noor N–18											1	3	7	9	4	5	1						41.0
No. 6	Mosque													5	9	6	5	3	2					41.9
	Fard No. 4								1	3	4	9	5	3	4	1								39.5
	Deglet Noor R–1									2	4	2	6	6	7	3								40.4
	Deglet Noor R–6											1		2	5	7	6	5	3	1				43.5
No. 7	Fard No. 4											4	6	7	8	3	1	1						41.2
	Fard FNJ–S											3	2	9	10	2	4							41.6
	Canariensis No. 2 (15).							1	1	4	5	2	1	1										37.9
	Maktum No. 5										1		4	4	10	3	3	4	1					42.3
	Maktum No. 6												3	6	8	12	1							42.1
	Maktum No. 7											1	5	4	13	2	2	3						41.9
No. 8	Mosque												2	1	5	7	10	4		1				43.3
	Fard No. 4					2	5		11	4	4	1	1	2										36.4
	Menakher No. 1													5	4	3	6	6	3	2	1			43.9
	Theory No. 20													3	3	9	8	5	2					43.5
	Saidy No. 25												1	4	8	5	8	3	1					42.9
	Fard FNJ–N										2	6	5	6	7	3	1							40.8
	Deglet Noor N–9								1			3	6	2	4	6	4	3	1					41.9
	Ascherasi										2	1	5	7	7	6	2							41.4
No. 9	Mosque												1	7	5	7	7	2		1				42.8
	Fard No. 4									1	3	5	7	3	6	4	1							40.6
	Fard FNJ–S										9	3	13	4	1									39.5
	Canariensis No. 2					1		1	2	8	9	4	4	1										37.8
	Deglet Noor N–9										1	2	4	3	7	10	3							41.8
No. 10	Ascherasi										1		5	7	8	6	3							41.7
	Deglet Noor N–9												1	7	9	13								42.1
	Theory No. 20												2		5	6	11	2	4					43.5
No. 11	Fard No. 4												2	6	6	7	6	3						32.6
	Fard FNJ–N												2	3	4	5	12	2	1	1				43.2
	Saidy No. 25															7	7	7	7	2				44.7
	Deglet Noor N–9												1	4	7	8	4	4	2					43.0
No. 12	Maktum No. 5											1	6	10	6	4	2	1						40.5
	Maktum No. 6											2	6	5	1	10	5	1						41.0
	Theory No. 20											2	1	4	5	5	8	2	1	2				42.0
No. 13 (on Deglet Noor seedling No. 6).	Mosque													2	2		7	5	2	3	3	1	3	2	44.9
	Fard No. 4									1			2	4	7	5	1	8	1	1				42.9
	Canariensis No. 2									2	1	5	10	5	3	3	1							40.3
No. 14 (on Rhars)	Mosque (15)															2		5	6	2				44.4
	Fard No.4 (7)												1		1	1	2		1	1				43.7
	Canariensis No. 2 (20).									1	1	5	7	3	3									39.9
No. 15 (on Khadrawy).	Mosque (20)			2	4	4	6	3																33.1
	Fard No. 4 (20)	4	6	6	2	2																		30.6
No. 16 (on Maktum)	Mosque (8)			3	1		2		2															33.1
	Fard No. 4 (20)			1	4	3	5	5	1	1														31.8
	Maktum No. 5 (20)			6	10	3	1																	32.0
No. 17	Mosque															2		5	8	7	6	1	1	46.5
	Fard RB No. 1													1		4	8	6	6	5				44.9
No. 18	Mosque															1	7	13	4	4	1			45.2
	Fard A–21–2–32											4	1	3	3	5	4	5	3	2				43.1

TABLE 10.—*Length of seeds of date fruits in the 1926 experiments at Indio, Calif.*

[Measurements of 30 fruits were made except where a smaller number is indicated in parentheses]

Experiment	Pollen used	Measurements (millimeters) and frequencies														
		17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Mean
No. 1	Mosque							2	7	6	8	3	2	1	1		25.6
	Fard No. 4				2	4	11	7	4		1	1					22.5
	Canariensis No. 2			5	10	7	7	1									20.6
	Deglet Noor N-12							6	12	8	2		2				24.5
	Fard FNJ-S				1	3	13	6	5	2							22.6
	Fard FNJ-N					3	7	4	10	3	1	1	1				23.5
	Menakher No. 1							5	6	11	4	3	1				24.9
	Maktum No. 5							9	10	9	1	1					24.2
	Deglet Noor R-6						1	2	6	12	7	1	1				25.0
No. 2a	Mosque							1	1	3	7	9	3	5	1		26.9
	Fard No. 4						1		8	14	5	2					24.9
	Canariensis No. 3				3	7	9	6	4	1							22.1
	Maktum No. 5						2	1	2	6	4	10	3	1	1		26.1
No. 2b	Fard FNJ-S				1	1	2	9	11	4		2					23.7
	Fard FNJ-N						1	9	11	4	3	2					24.2
	Deglet Noor N-10					2	5	5	9	6	2	1					23.7
	Mosque						1	3	8	11	4	3					24.8
	Fard No. 4					1	12	9	2	6							23.0
	Deglet Noor N-18						1	1	6	7	9	3	1	1	1		25.5
No. 3	Mosque				2	3	5	8	7	4	1						23.0
	Fard No 4						1	1	2	14		8	3	1			25.7
	Canariensis No. 3	1	1	7	9	9	1	2									20.1
	Government No. 1							1	3	12	8	6					25.5
No. 4	Mosque								1	3	8	8	5	3	2		27.0
	Fard No. 4			1		6	5	13	4	1							22.5
	Canariensis No. 2	1	2	6	9	7	3	1	1								20.9
	Deglet Noor N-12						4	13	8	5							23.5
No. 5	Mosque							2	3	6	7	8	2	2			26.0
	Fard No. 4			2	2	11	8	4	1	1		1					21.8
	Saidy No. 13						1	6	8	7	8						24.5
	Deglet Noor N-18							11	8	7	3	1					24.2
No. 6	Mosque								4	3	11	8	4				26.2
	Fard No.4						1	8	7	7							23.4
	Deglet Noor R-1						2	3	3	12	6	3	1				24.0
	Deglet Noor R-6								1	2	4	14	6	1	1	1	26.1
No. 7	Fard							6	6	10	4	2	2				23.9
	Fard FNJ-S						1	1	4	6	13	2	3				24.6
	Canariensis No. 2 (15)			1	1	2	8	2	1								21.8
	Maktum No. 5						3	5	4	8	6	4					24.7
	Maktum No. 6							5	7	5	10	1	2				25.0
	Maktum No. 7						1	7	10	3	5	4					24.5
No. 8	Mosque						2	2	4	10	6	5	1				25.2
	Fard No. 4			3	5	8	7	4	3								21.4
	Menakher No. 1						1	1	2	6	8	8		3	1		26.1
	Thoory No. 20						1	2	5	8	9	5					25.2
	Saidy No. 25							1	3	9	7	9	1				25.8
	Fard FNJ-N						2	9	6	6	6		1				24.3
	Deglet Noor N-9					1	3	1	6	5	7	4	2	1			25.1
	Ascherasi						3	3	4	9	9	1		1			24.9
No. 9	Mosque							5	5	9	5	5	1				25.1
	Fard No. 4			1		10	8	7	2	2							22.1
	Fard FNJ-S				5	7	11	4	2	1							21.8
	Canariensis No. 2	3	4	10	8	3	2										19.3
No. 10	Deglet Noor N-9					1	5	5	9	6	2	2					23.9
	Ascherasi							6	9	10	2	3					24.6
	Deglet Noor N-9						1	4	5	13	4	2	1				24.8
	Thoory No. 20						1		4	11	6	4	4				25.6
No. 11	Fard No. 4							5	9	6	7	3					24.8
	Fard FNJ-N							3	5	8	11	3					25.2
	Saidy No. 25								1	4	6	9	7	2		1	26.9
	Deglet Noor N-9								3	6	12	7	2				26.0
No. 12	Maktum No. 5						4	5	11	7	2	1					23.0
	Maktum No. 6							5	6	6	7	5	1				24.1
	Thoory No. 20					1	4	5	8	8	3	1					24.0
No. 13 (on Deglet Noor seedling No. 6).	Mosque						8	4	8	9	1						23.7
	Fard No. 4				10	7	7	4	2								21.4
	Canariensis No. 2	6	7	10	6	1											18.6
No. 14 (on Rhars)	Mosque (15)										4	2	7	2			27.4
	Fard No. 4 (7)								1	3		3					25.7
	Canariensis (20)				1	2	5	7	4		1						22.8
No. 15 (on Khadrawy)	Mosque (20)			2	8	8	2										20.5
	Fard No. 4 (20)		9	8	3												18.7
No. 16 (on Maktum)	Mosque (8)			1	2	5											20.5
	Fard No. 4 (20)	1	3	6	10												19.3
	Maktum No. 5 (20)	1	1	12	5	1											19.2
No. 17	Mosque								3	5	9	5	6	1	1		26.4
	Fard RB No.1					1	1	8	9	5	5	1					24.2
No. 18	Mosque							2		6	8	5	7	1		1	26.5
	Fard A-21-2-32					1	6	10	5	5	3						23.5

TABLE 11.—*Breadths of date fruits and seeds in the 1926 experiments at Indio, Calif.*

[Measurements of 30 fruits were made except where a smaller number is indicated in parenthesis]

Experiment	Pollen used	Fruit measurements (millimeters) and frequencies											Seed measurements (millimeters) and frequencies						
		17	18	19	20	21	22	23	24	25	26	Mean	5	6	7	8	9	10	Mean
No. 1	Mosque			4	13	11	2					20.4				21	8	1	8.3
	Fard No. 4		6	6	13	5						19.6			22	8			7.3
	Canariensis No. 2	3	12	7	5	2	1					18.8	1	15	14				6.4
	Deglet Noor N-12			9	12	6	3					20.1			16	12	2		7.5
	Fard FNJ-S		6	13	8	3						19.3		2	26	2			7.0
	Fard FNJ-N		1	8	11	7	3					20.1		3	20	5	2		7.2
	Menakher No. 1		2	4	11	9	4					20.3		1	11	15	3		7.7
	Maktum No. 5			7	11	8	4					20.3			6	20	4		7.9
	Deglet Noor R-6		2	10	10	7	1					19.8			4	20	6		8.1
No. 2a	Mosque				6	13	11					21.2				13	17		8.6
	Fard No. 4			1	9	14	6					20.8			21	9			7.3
	Canariensis No. 3	1	5	4	10	8	2					19.8		16	13	1			6.5
	Maktum No. 5			2	11	7	9	1				20.9			9	19	2		7.8
No. 2b	Fard FNJ-S		1	7	19	3						19.8			16	14			7.5
	Fard FNJ-N			1	12	10	7					20.8		3	21	6			7.1
	Deglet Noor N-10			8	12	8	2					20.1		1	25	4			7.1
	Mosque			3	12	10	5					20.6				15	15		8.5
	Fard No. 4			4	15	11						20.2		4	24	2			6.9
	Deglet Noor N-18		1		9	10	10					20.9		1	14	14	1		7.5
No. 3	Mosque		10	10	9	1						19.0			1	17	12		8.4
	Fard No. 4	2	14	12	2							18.5		1	11	18			7.6
	Canariensis No. 3	12	12	4	2							17.9	1	21	7	1			6.3
	Government No. 1		1	8	20	1						19.7			2	20	8		8.2
No. 4	Mosque			1	3	7	12	4	3			21.8			1	11	17	1	8.6
	Fard No. 4		1	2	11	7	9					20.7		2	16	12			7.3
	Canariensis No. 2		2	7	14	6	1					19.9		12	18				6.6
	Deglet Noor N-12			2	15	9	4					20.5			26	3	1		7.2
No. 5	Mosque			3	13	9	3	2				20.6			2	21	7		8.2
	Fard No. 4		2	5	15	7	1					20.0		1	18	11			7.3
	Saidy No. 13		2	7	11	5	5					20.1		1	3	23	3		7.9
	Deglet Noor N-18		2	8	14	6						19.8			12	17	1		7.6
No. 6	Mosque		1	2	18	9						20.2			1	22	7		8.2
	Fard No. 4		1	3	14	10	2					20.3			15	15			7.5
	Deglet Noor R-1			2	14	10	3	1				20.6			6	21	3		7.9
	Deglet Noor R-6		1	11	11	7						19.8			5	21	4		8.0
No. 7	Fard No. 4				7	13	10					21.1			25	4	1		7.2
	Fard FNJ-S				2	9	14	5				21.7			18	11	1		7.4
	Canariensis No. 2 (15)			4	4	3	4					20.5	1	4	9	1			6.7
	Maktum No. 5			2	6	14	7	1				21.0			10	17	3		7.7
	Maktum No. 6			3	3	16	4	4				21.1			12	18			7.6
	Maktum No. 7				10	9	9	2				21.1			4	24	2		7.9
No. 8	Mosque			1	5	10	8	6				21.4			5	18	7		8.1
	Fard No. 4			3	16	9	2					20.3		2	20	7	1		7.2
	Menakher No. 1				2	1	9	12	5	1		22.7			2	21	7		8.2
	Thoory No. 20					5	11	13	1			22.3			4	21	4	1	8.1
	Saidy No. 25				3	9	14	2	1	1		21.7			8	18	3	1	7.9
No. 9	Fard FNJ-N				6	11	10	3				21.3			11	18	1		7.7
	Deglet Noor N-9			1	3	12	8	6				21.5			7	20	3		7.9
	Ascherasi				3	10	16	1				21.5			5	23	2		7.9
	Mosque		1	7	14	6	2					20.0			1	17	12		8.4
	Fard No. 4	1	5	8	12	4						19.4		3	18	9			7.2
	Fard FNJ-S		4	16	9	1						19.2			19	11			7.4
	Canariensis No. 2	3	12	13	2							18.5		13	17				6.6
	Deglet Noor N-9		3	19	6	2						19.2			10	19	1		7.7
No. 10	Ascherasi			1	9	14	6					20.8			3	24	3		8.0
	Deglet Noor N-9			1	9	11	8	1				21.0			8	22			7.7
	Thoory No. 20			1	2	12	14	1				21.4			2	25	3		8.0
No. 11	Fard No. 4			1	5	14	10					21.1			24	6			7.2
	Fard FNJ-N				4	13	12	1				21.3			22	8			7.3
	Saidy No. 25				2	7	14	7				21.8			1	23	6		8.2
	Deglet Noor N-9				3	9	15	3				21.6			4	25	1		7.9
No. 12	Maktum No. 5			2	12	12	4					20.6			1	24	5		8.1
	Maktum No. 6		1	6	16	6	1					20.0			4	24	2		7.9
	Thoory No. 20			2	12	12	4					20.6			5	24	1		7.9
No. 13 (on Deglet Noor seedling No. 6).	Mosque				6	9	13	2				21.4			14	14	2		7.6
	Fard No. 4			4	10	12	4					20.5		4	24	2			6.9
	Canariensis No. 2		3	5	15	6	1					19.9		21	9				6.3
No. 14 (on Rhars).	Mosque (15)				4	5	5	1				21.2				10	5		8.3
	Fard No. 4 (7)			1	2		4					21.0			2	5			7.7
	Canariensis No. 2 (20)		1	2	13	3	1					20.1		1	13	6			7.3

TABLE 11.—*Breadths of date fruits and seeds in the 1926 experiments at Indio, Calif.*—Continued

Experiment	Pollen used	Fruit measurements (millimeters) and frequencies											Seed measurements (millimeters) and frequencies						
		17	18	19	20	21	22	23	24	25	26	Mean	5	6	7	8	9	10	Mean
No. 15 (on Khadrawy).	Mosque (20)				2	2	11	4	1			22.0				9	11		8.6
	Fard No. 4 (20)			2	5	9	4					20.8			4	16			7.8
No. 16 (on Maktum).	Mosque (8)								6		2	24.5			1	6	1		8.0
	Fard No. 4 (20)					1	7	11	1			22.6			10	10			7.5
	Maktum No. 5 (20).						9	7	4			22.8			8	12			7.6
No. 17	Mosque			1	6	12	10	1				21.1				13	16	1	8.6
	Fard RB No. 1			8	13	6	3					20.1			16	14			7.5
No. 18	Mosque			1	9	12	7	1				20.9			2	14	14		8.4
	Fard A-21-2-32			6	15	7	2					20.2		2	17	11			7.3

In every experiment the pollen from Mosque produced larger fruit (fig. 6, D) and seed (fig. 5, B, and 7) than that from Fard No. 4. Since for these two pollens the breadths showed a tendency to vary in the same direction, the lengths afford the best basis for comparison. In all but one of the seven experiments on Deglet Noor in 1925 the mean difference of fruit lengths was more than three times its probable error,[5] the least significant difference in six of the experiments being 1.6 ± 0.16 mm. in experiment 2 (100 measurements). The mean difference of seed lengths was significant in every one of the seven, the least being 1.5 ± 0.28 mm. in experiment 6 (45 measurements). Considering each mean as a unit, the average mean difference[6] for these seven experiments was 2.2 ± 0.3 mm. for the fruit and 3.1 ± 0.25 mm. for the seed.

TABLE 12.—*Average of 10 measurements of fruits and seeds in the 1926 experiments in the Salt River Valley, Ariz.*

Experiments 1–7 were at the Tempe Date Garden, and experiments 8 and 9 were at the garden of the Arizona Orchards Company]

Experiment	Pollen used	Fruits		Seeds	
		Length	Breadth	Length	Breadth
No. 1	Mosque	42.1	21.1	25.1	8.5
	Fard	39.1	19.6	22.5	7.6
No. 2	Mosque	42.4	23.9	25.3	8.1
	Fard	39.0	21.0	22.2	7.4
No. 3	Mosque	42.4	21.2	24.9	8.4
	Fard	39.7	20.0	21.7	7.4
No. 4	Mosque	43.8	22.7	26.4	8.3
	Fard	40.6	20.0	22.5	7.1
	Fard FNJ-S	41.4	21.4	24.1	7.4
	Fard FNJ-N	41.5	21.3	22.8	7.3
No. 5	Mosque	42.9	21.6	24.6	8.8
	Fard	39.3	20.0	20.9	7.3
	Fard FNJ-S	40.8	20.9	21.4	7.4
	Fard FNJ-N	40.8	20.8	22.3	7.6
No. 6	Mosque	42.6	21.4	25.1	8.1
	Fard	40.0	20.4	22.5	7.3
	Fard FNJ-S	40.0	20.4	22.5	7.2
No. 7	Mosque	40.2	19.4	23.1	7.7
	Fard	38.8	19.3	21.9	7.9
No. 8	Mosque	43.2	23.6	26.4	9.4
	Fard	42.4	22.1	23.4	8.0
No. 9 (Iteema)	Mosque	43.8	24.0	26.9	10.1
	Fard	41.0	22.5	23.5	8.6

[5] For the probable error of the mean the formula used is $PE = 0.6745 \sqrt{\frac{\Sigma v^2}{n(n-1)}}$

[6] PEARSON, K. ON THE PROBABLE ERROR OF A COEFFICIENT OF MEAN SQUARE CONTINGENCY. Biometrika 10: 570–573. 1915.

All of the 1926 experiments on Deglet Noor at the Indio station showed a significant mean difference between the Mosque and the Fard No. 4 pollinations, the least for the fruit being 1.3 ± 0.21 mm.

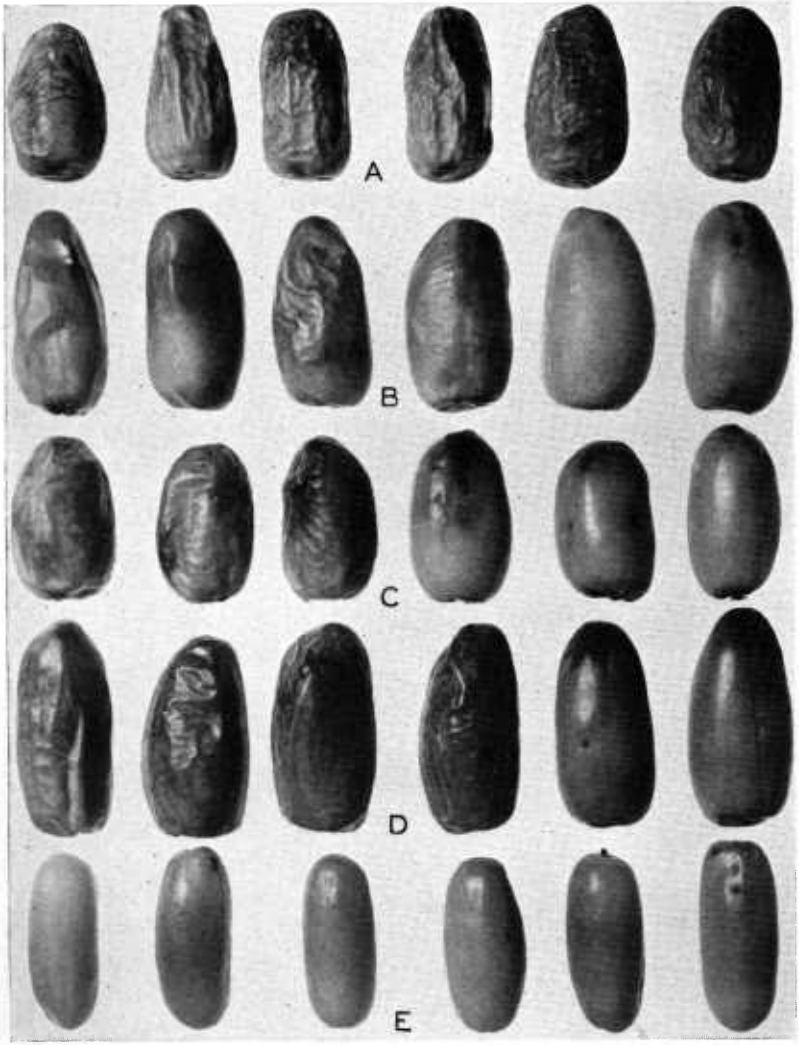

FIG. 6.—Typical dates of the Deglet Noor variety produced by different pollens on the same cluster in experiment 4 in 1925. The male palms represented are: A, Fard No. 4; B, Government No. 1; C, Canariensis No. 1; D, Mosque; and E, unpollinated dates. The dates from Fard No. 4 pollen were all full ripe on September 11, when the photograph was taken, but there were still immatre dates on all the other strands

and for the seed, 1.8 ± 0.21 mm. The average mean for nine experiments was 3.4 ± 0.39 mm. for the fruit and 3.1 ± 0.21 mm. for the seed.

In the Salt River Valley experiments in 1926 ten measurements were made in each pollination. (Table 12.) These measurements were comparable to the larger number made at Indio, the average mean difference in length for eight experiments with Mosque and

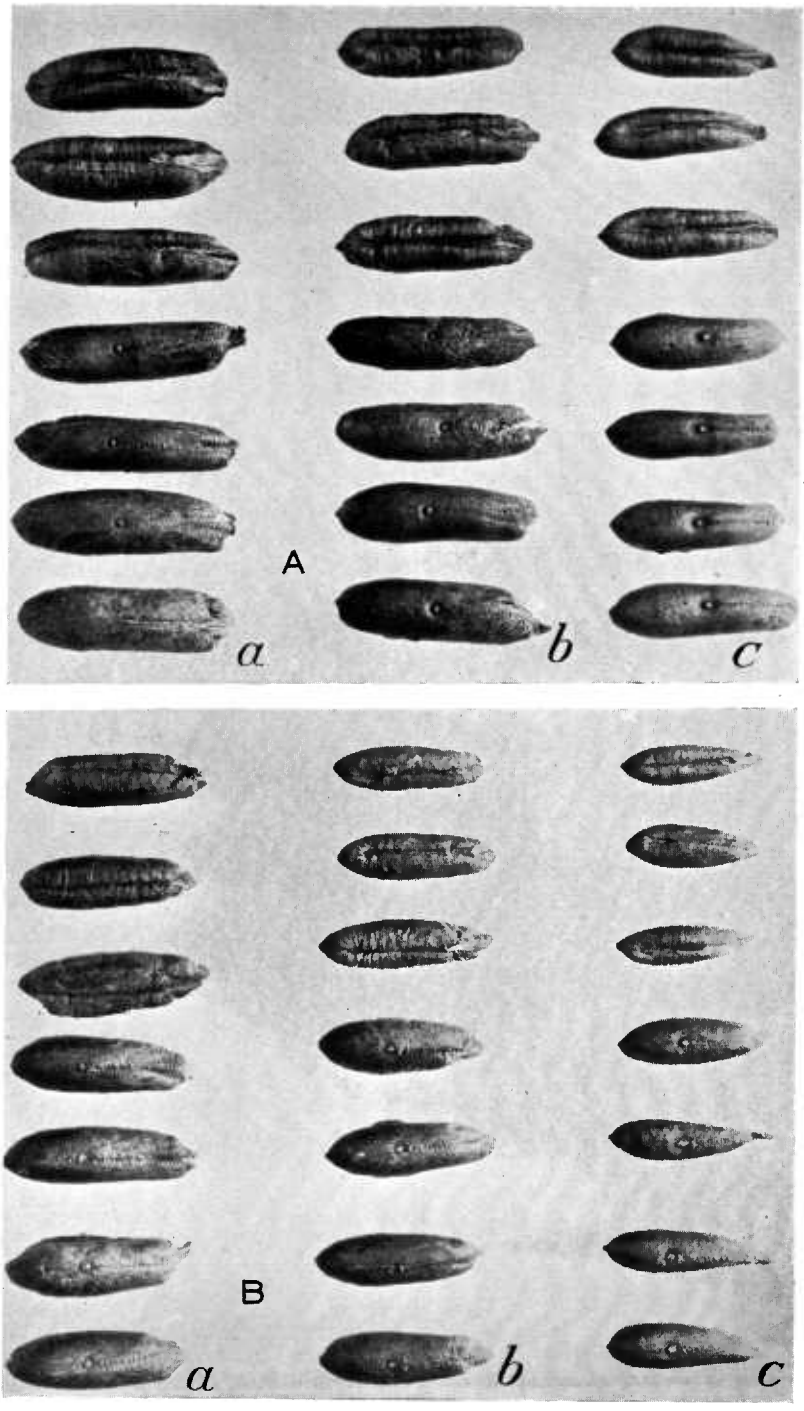

FIG. 7.—A.—Typical Rhars seeds produced on the same cluster by different pollens in experiment 14 in 1926. The male palms represented are: *a*, Mosque; *b*, Fard No. 4; and *c*, Canariensis No. 2. B.—Typical seeds from Deglet Noor seedling No. 6 produced on the same cluster by different pollens in experiment 13 in 1926. The male palms represented are: *a*, Mosque; *b*, Fard; and *c* Canariensis No. 2

Fard No. 4 on Deglet Noor being 2.6 ± 0.25 mm. for the fruit and 2.9 ± 0.21 mm.for the seed.

That this increase in size is accompanied by an increase in weight is indicated by the results of determinations in nine experiments with Deglet Noor at Indio in 1926. The mean weight of the seed was 102 gm. per 100 for the pollinations with Mosque and 68.3 gm. per 100 for the pollinations with Fard No. 4, a difference of 33.7 ± 1.85 gm., or 49.3 per cent. For the fruit the mean dry weight of flesh only was 725.1 gm. per 100 for pollinations with Mosque and 623.2 gm. per 100 for the pollinations with Fard No. 4, a difference of 101.9 ± 21.54 gm., or 16.4 per cent. In the weights, as in the measurements, it is apparent that the effect on the flesh is proportionately smaller and more variable than on the seed. By way of comparison, the seed in four experiments with pollen of *Phoenix canariensis* averaged 45.1 gm. per 100, while the dry weight of flesh only in three experiments averaged 602.8 gm. per 100.

It seems more than likely that these pollens will affect the fruit of other varieties in a similar manner. The results of two seasons' experiments with Deglet Noor seedling No. 6 and of a preliminary test with each of the varieties Rhars, Khadrawy, Maktum, and Iteema in 1926, included with the other tabulations, are entirely in harmony with the results obtained with the Deglet Noor variety.

DIFFERENCES IN QUALITY

So far no differences in the fruit as regards texture, flavor, etc., have been found to appear consistently in all of the experiments. This applies to all of the pollens tested. Through the courtesy of A. F. Sievers, of the Bureau of Plant Industry, United States Department of Agriculture, sugar analyses were made of the fruit in one experiment in 1925 with pollens from five male palms represented including Mosque, Fard No. 4, and Canariensis No. 1, and in two experiments in 1926, Mosque and Fard No. 4 being represented in both and Canariensis No. 2 in one. As all of the samples had been stored for some weeks before they were sent to the laboratory, the effect of storage may be questioned, but the results of the analyses did not indicate any significant differences in the sugar content. The likelihood that pollen has any direct effect on the sugar of the date would seem to be lessened by the fact that the sugar content of two samples of "unpollinated dates," one in 1925 and one in 1926, which finally ripened about three months after those which received pollen, varied less than 2 per cent from that of the nearest pollinated fruit.

Except in so far as the size and proportions of the seeds and fruits may be involved, the evidence in hand does not indicate any direct effect of pollen on the fruit which would properly come within the scope of the rather indefinite term "quality." But there is an indirect influence. In the Coachella Valley, Calif., it is a matter of common observation among date growers that Deglet Noor dates ripening very early in the extreme heat of late summer show a distinct tendency to be inferior in quality to the fruit which ripens later in the season when the weather is cooler. Perhaps the reverse may occur in other localities where climatic conditions are frequently unfavorable during the latter part of the ripening season. In either case, pollen by varying the time of ripening of the fruit might indirectly affect the quality

of a large proportion of the crop. Furthermore, it should be noted that differences in the time of ripening due to pollen may be at any season indirectly responsible for apparent differences in texture by causing one set of fruit to mature during a period of lower humidity than another. Hence, from a small number of experiments it might appear that one pollen was actually producing a softer date than another, whereas the results under other conditions with reverse fluctuations of relative humidity would be exactly the opposite.

In the seeds, the chief difference other than size produced by pollen was in the color. While the range was such that an individual seed could not have been identified with certainty on that basis, it was apparent in every experiment on Deglet Noor that the seeds resulting from pollinations with Mosque were lighter than those from pollinations with Fard No. 4, the former ranging from light drab (R. XLVI) to wood brown (R. XL), while the latter ranged from wood brown (R. XL) to snuff brown (R. XXIX). Seeds from pollen of *Phoenix canariensis* were even darker, verona brown (R. XXIX) being the prevailing shade. The peculiar tapering base produced by pollen of *P. canariensis* on the seeds of Deglet Noor fruit has already been mentioned. This tapering tendency in a lesser degree also occurred in the pollinations with *canariensis* on Rhars and Deglet Noor seedling No. 6.

OTHER MALE PALMS TESTED

If it were only by some fortunate accident that Mosque and Fard No. 4 proved to be so diverse and no other males could be shown to vary in such proportion, the immediate practical value of these experiments would be of somewhat less consequence, for the hope of the future would be largely dependent on breeding through a long period of years. However, it is now clear that there are *dactylifera* males equally as late as Mosque and others equally as early as Fard No. 4.

As mentioned above, from one to four preliminary tests were made at the Indio station with pollen from each of 20 other palms of *Phoenix dactylifera* and three of *P. canariensis*. Most of the *dactylifera* males ranged between Mosque and Fard No. 4, and, as might be expected from the nature of ripening there were many minor fluctuations. Yet at least five (Fard FNJ–S, Fard FNJ–N, Fard RB No. 1, Fard A–21–2–32, and Deglet Noor N–12, two of which are shown in Figure 3) appeared comparable to Fard No. 4 and three (Deglet Noor R–6, Deglet Noor N–9, and Huey, the last being designated by the name of the owner of the palm located near Bard, Calif.) to Mosque. It will be noted that of the male palms producing early-ripening fruits four of the five just mentioned are seedlings of the Fard variety. One of these (Fard FNJ–N) showed a tendency to ripen fruit even earlier than Fard No. 4. Whether any corresponding uniformity may occur among the seedling males of other varieties is for future tests to determine, but in these preliminary tests it did not occur among the several seedling males of the Deglet Noor variety, one of which was comparable to Fard No. 4 and two about on a par with Mosque.

The results of these preliminary tests will of course be subject to further verification, but from the consistent behavior of the pollens of Mosque and Fard No. 4 in every test during a period of two years

such verification may be expected to be largely a determination of the exact lateness or earliness of ripening produced. In other words, because of the range of experimental error a small number of tests may not indicate with certainty whether one pollen is a trifle later than Mosque or another a trifle earlier than Fard No. 4, yet there can be little doubt even from a few careful experiments that the one is definitely a late pollen and the other definitely an early one.

So far no exact correlation between size and earliness of fruit has been found. Yet this much is apparent, that among the male palms of *Phoenix dactylifera* no early pollens produced very large fruits or seeds and no late pollens produced very small fruits or seeds.

On the other hand, the smallest fruits and seeds produced in any of these tests were from the pollen of *Phoenix canariensis*. Pollens from two palms of this species, Nos. 1 and 2, ripened the fruit even later than the Mosque, while the third, No. 3, ripened the fruit somewhat earlier.

It seems very questionable whether the limits of variation have yet been reached. On the contrary, the diversity among the few already tested makes it more than likely that among the hundreds of males scattered wherever palms are grown there are many which will produce, and are producing, variations as great as or greater than those that appeared in any of these experiments.

SUMMARY

To test the direct effect of pollen on the fruit of the date palm, experiments were made at the United States Experiment Date Garden at Indio, Calif., in 1925 and 1926,[7] with additional tests in the Salt River Valley, Ariz., in 1926. Pollens from 25 staminate palms, 22 seedlings of *Phoenix dactylifera*, and 3 of *P. canariensis* were used on pistillate palms of the Deglet Noor variety. In some of the experiments successive inflorescences were pollinated, each with a different pollen. In most of them several pollens were applied, each to a different set of strands on the same inflorescence. Including two tests on a Deglet Noor seedling palm and one each on the Rhars, Khadrawy, Iteema, and Maktum varieties, two of the pollens which produced diverse effects were directly compared in 30 experiments. The resulting fruit and seed showed consistent differences according to the source of the pollen.

Significant differences were produced in the size and proportions of the seed.

Pollen from *Phoenix canariensis* affected the shape of the seed by producing a distinct, tapering base.

Variations in the size of the seed were accompanied by differences in the size of the fruit itself, though the latter were proportionately less than the former.

The most striking effect of pollen was a difference in the time of ripening of the fruit, which in some of the experiments was as much as 10 days in the early part of the season, with a tendency to increase in the latter part of the season.

[7] A still more extensive series of pollination experiments was conducted in 1927. The data, as far as they have been assembled and studied prior to the publication of this article, completely verify the results obtained in 1925 and 1926.

Xenia, known to occur in corn, wheat, and many other plants, may be the explanation of the direct effect of pollen on the seed, but it does not account for the influence on the fruit outside the embryo and endosperm. The data suggest an interrelation,[8] heretofore unrecognized, between the embryo and endosperm and the tissues outside.

These experiments indicate the importance of a further study of the pollination problems involved in date culture, but they are of immediate significance to date growers, emphasizing the need for careful selection of male palms. It is evident that pollen may be utilized as a factor in obtaining high-grade standardized fruit, and through its influence on the time of ripening it may be a means of adapting date culture to minor climatic variations.

[8] For the direct effect of pollen on the tissues of the mother plant outside the embryo and endosperm, Walter T. Swingle, under whose direction the experiments herein reported were initiated, has proposed the term "metaxenia," first in a report and discussion of the evidence at the meeting of the Southwestern Division of the American Association for the Advancement of Science at Phoenix, Ariz., Feb 15–18, 1926. Later a more complete discussion was presented in two papers read by Swingle before the International Congress of Plant Sciences at Ithaca, N. Y., August 16–23, 1926, under the following titles, abstracts of which appear in the proceedings of the congress: SWINGLE, W. T. HYPOTHETICAL EXPLANATION OF METAXENIA OR EFFECTS EXERTED BY THE MALE PARENT ON TISSUES OF THE MOTHER PLANT LYING OUTSIDE OF THE EMBRYO AND ENDOSPERM. [Unpublished manuscript.]

—— and NIXON, R. W. THE EFFECTS EXERTED BY DIFFERENT POLLENS ON THE DEVELOPMENT OF THE FRUIT OF THE DATE PALM. [Unpublished manuscript.]